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An assessment of the Lake Winnipegosis walleye rearing ponds and their contribution to the Lake Winnipegosis commercial fishery.

MANITOBA
DEPARTMENT OF NATURAL RESOURCES
Fisheries Branch

MS Report No. 82-25, 96pp.
1982

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ABSTRACT

Walleyes within the rearing ponds were opportunistic feeders and ate what was seasonably abundant and available. Micro-crustaceans were the main food types chosen by rearing pond walleyes within a couple of weeks after hatching. At about 30 days of age the walleyes diet began to diversify from cladocerans and copepods and by approximately 40 days from hatching the walleyes were usually feeding on larger organisms. These food types were usually chironomids, dipteran pupae, forage fish and amphipods.

Walleye growth varied between ponds and between years. In 1980 and 1981, average lengths of 62 to 68 mm were attained by 56 to 60 day old walleyes. The average length of walleyes at release time (120 to 130 days of age) was usually 100 mm or more. Walleye growth was rapid from hatching and generally levelled off at about 75 to 80 days after hatching.

An analysis of covariance ($P \leq 0.05$) conducted on the length growth curves did show some significant differences for the comparisons made. These differences occurred when walleye growth curves from all four study years (1978 - 1981) were compared simultaneously.

Rearing ponds stocked at lower rates (no. fry ha^{-1}) or lower densities (no. fry 100 m^{-3}) frequently achieved better walleye growth than those ponds stocked at higher rates or densities. Linear regression of growth curves for 14 - 70 day old walleyes showed a better growth rate with a lower stocking density. The cooling effect of water temperature between 40 - 100 days after hatching also appeared to influence walleye growth. This influence seemed to affect the time at which the walleyes growth began to attenuate.

A multiple regression analysis involving water temperature, stocking density and walleye growth from Coleman Pond indicated that neither water temperature nor stocking density had a significant effect ($P \leq 0.05$) on walleye growth.

The number of walleyes released was usually 5 to 12 percent of the numbers stocked. The highest release was 32 percent. Average releases, particularly from Coleman and Freshwater ponds, appeared to be in the range of 20 to 50 percent of the population estimates. Production estimates varied from 1.0 to 9.0 kg ha^{-1}. The most typical production levels were 3 to 5 kg ha^{-1}.

Recoveries of spray marked walleyes in the commercial fishery indicate that rearing pond walleyes contribute less than one percent to those cohorts which were being recruited. Mark recoveries of age 3+ and older walleyes represented one to 3 percent of the 1977 and 1978 cohorts sampled from otter trawl catches. Reared walleyes appeared to make the greatest contribution as yearling fish.

TABLE OF CONTENTS

	Page
ABSTRACT	i
INTRODUCTION	1
METHODS	6
RESULTS	11
Pond Stocking	11
Food	13
Coleman Pond	21
Freshwater Pond	23
Kelly Pond	25
Growth	27
Population and Survival Estimates	39
Releases and Production	40
Mark Recaptures	43
DISCUSSION	47
Pond Stocking	47
Food	48
Growth	52
Rearing Pond Contributions to Lake Winnipegosis	56
SUMMARY	69
ACKNOWLEDGMENTS	74
LITERATURE CITED	75

LIST OF TABLES

Table		Page
1.	Walleye rearing pond stocking rates, 1980 and 1981 .	12
2.	Mortality of caged walleye eggs and fry in Coleman and Freshwater ponds before stocking, 1980 and 1981.	12
3.	The mean fork length (mm) and mean weights (gm) of walleyes from Lake Winnipegosis rearing ponds, 1980.	29
4.	The mean fork length(mm) and mean weights (gm) of walleyes from Lake Winnipegosis rearing ponds, 1981.	29
5.	Length increments for walleyes from Lake Winnipegosis rearing ponds between sampling periods, 1980	33
6.	Length increments for walleyes from Lake Winnipegosis rearing ponds between sampling periods, 1981	33
7.	Covariance analysis of Lake Winnipegosis rearing pond walleyes growth data. Length and age transformed to natural log.	35
8.	Population estimates from Coleman and Freshwater walleye rearing ponds, 1980 and 1981	41
9.	Survival estimates from Coleman and Freshwater walleye rearing ponds, 1980 and 1981	41
10.	Numbers and percentage of walleyes released and production (wt.) of walleyes from walleye rearing ponds, 1978 to 1981	45

Table Page

11. Spray marked walleye recoveries obtained from commercial samples, ottertrawls and beach seines, 1977 to 1981 45

LIST OF FIGURES

Figure		Page
1.	Location of walleye rearing ponds developed near Lake Winnipegosis, Manitoba	2
2.	Location of the five rearing ponds in the Sagemace Bay - Duck Bay study area of Lake Winnipegosis . .	4
3.	(a) Sagemace Bay area where the majority of trawling and seining was done.	8
	(b) Portion of Lake Winnipegosis where trawling and beach seines were conducted	8
4.	Ultra-violet light table design used for checking walleyes caught by commercial fishermen	9
5.	Percent of walleye stomachs containing particular food items per sample period from Coleman Pond, 1978 and 1979	14
6.	Percent of walleye stomachs containing particular food items per sample period from Coleman Pond, 1980 and 1981	15
7.	Percent of walleye stomachs containing particular food items per sample period from Freshwater Pond, 1978, 1979 and 1981	16
8.	Percent of walleye stomachs containing particular food items per sample period from Kelly Pond, 1978 and 1979.	17
9.	Percent of walleye stomachs containing particular food items per sample period from Kelly Pond, 1980 and 1981	18

Figure Page

10. The percentage occurrence of individual food items in the gut in relation to all food items eaten by walleyes in each Lake Winnipegosis rearing pond , 1980 and 1981. N = total number of occurrences observed for all food items. 24

11. Mean fork length and mean weight growth curves (with associated stocking rates of fry number/ha) of walleyes from Lake Winnipegosis rearing ponds, 1980 and 1981. 30

12. Mean fork length (range and standard deviation) of walleyes from Lake Winnipegosis rearing ponds, 1980 and 1981 31

13. Linear regressions of 14 to 70 day old walleyes from Coleman and Freshwater ponds, 1978 to 1981 36

14. Growth curves(with associated stocking density) and corresponding mean weekly water temperatures from Coleman and Freshwater ponds, 1978 to 1981 37

INTRODUCTION

The walleye, *Stizostedion vitreum vitreum*, has been a very important species in the commercial fishery on Lake Winnipegosis. Substantial declines in walleye catches during the 1960's stimulated the development of nine walleye rearing ponds around the periphery of Lake Winnipegosis during the last decade (Fig. 1). All of these ponds are natural waterbodies, consisting of either shallow backbays or small permanent openwater ponds in close proximity to the lake. The rearing ponds range in size from 65 to 450 ha; average depths are usually less than 1.0 m. A brief description of the water chemistry of two rearing ponds are presented by (Campbell and Rowse, 1980). Because of low water levels, the invasion of northern pike into the rearing ponds, and occasional vandalism of the pond control structures, all rearing ponds have not been stocked every year.

Costs associated with the development of the rearing ponds were reduced by utilizing natural waterbodies. Most of the costs incurred were related to relatively minor modifications. These included dredging channels from Lake Winnipegosis to some rearing ponds or constructing dykes to block off backbays. Single control culverts were placed within the channels and dykes. Gates were installed on these culverts to prevent the escapement of stocked walleye fry during the rearing period.

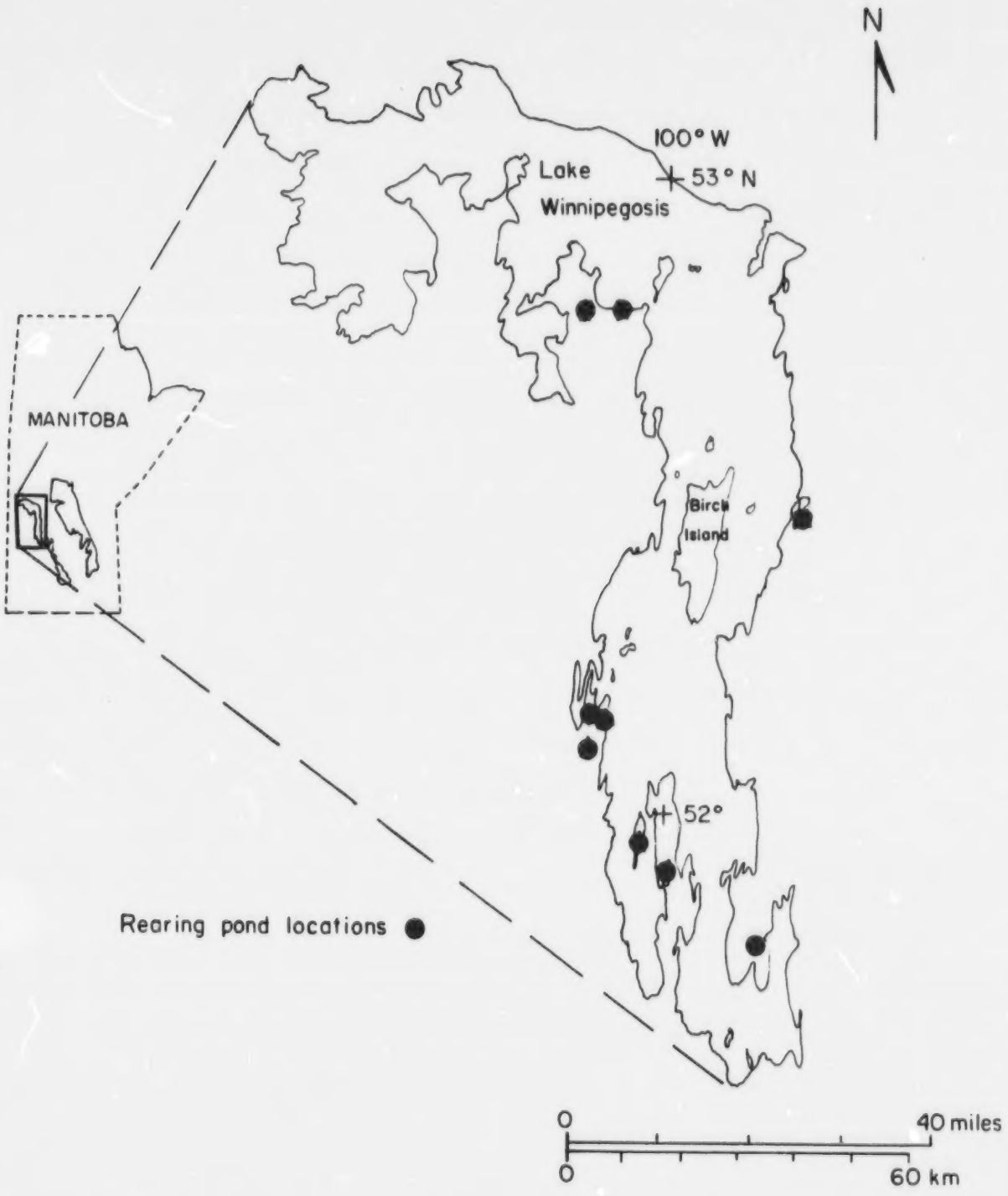

Fig. 1. Location of walleye rearing ponds developed near Lake Winnipegosis, Manitoba.

The principal objective of the Lake Winnipegosis walleye rearing program is to raise walleye fry to fingerling size in the absence of predators and in the presence of an abundant and assured supply of natural food. Previous studies, such as reviewed by Laarman (1978), have indicated that planting recently hatched walleye fry into large lakes has no significant correlation with the strengths of subsequent year classes. It was felt that the impact of walleye introductions on stock abundance would be greater if fingerlings, rather than fry, were released to Lake Winnipegosis. It was thought that the growth and survival of walleye fry could be greatly improved by stocking them in natural rearing ponds.

The present study was initiated in 1978 to evaluate the success of the walleye rearing program and to determine the impact of rearing pond production on the Lake Winnipegosis walleye fishery. The assessment of growth and survival of stocked walleye was limited to the five rearing ponds in the Sagemace Bay - Duck Bay area (Fig. 2). Two of these ponds were studied more intensively. These ponds were Coleman and Freshwater (Fig. 2); they were stocked with measured quantities of advanced eggs. A less comprehensive study was conducted on the other three ponds since they were stocked with numbers of walleye fry which had been estimated by visual observation. The three ponds were Chartrand, Kelly, and Pacheta. Results from these ponds provided a comparison with data from Coleman and Freshwater.

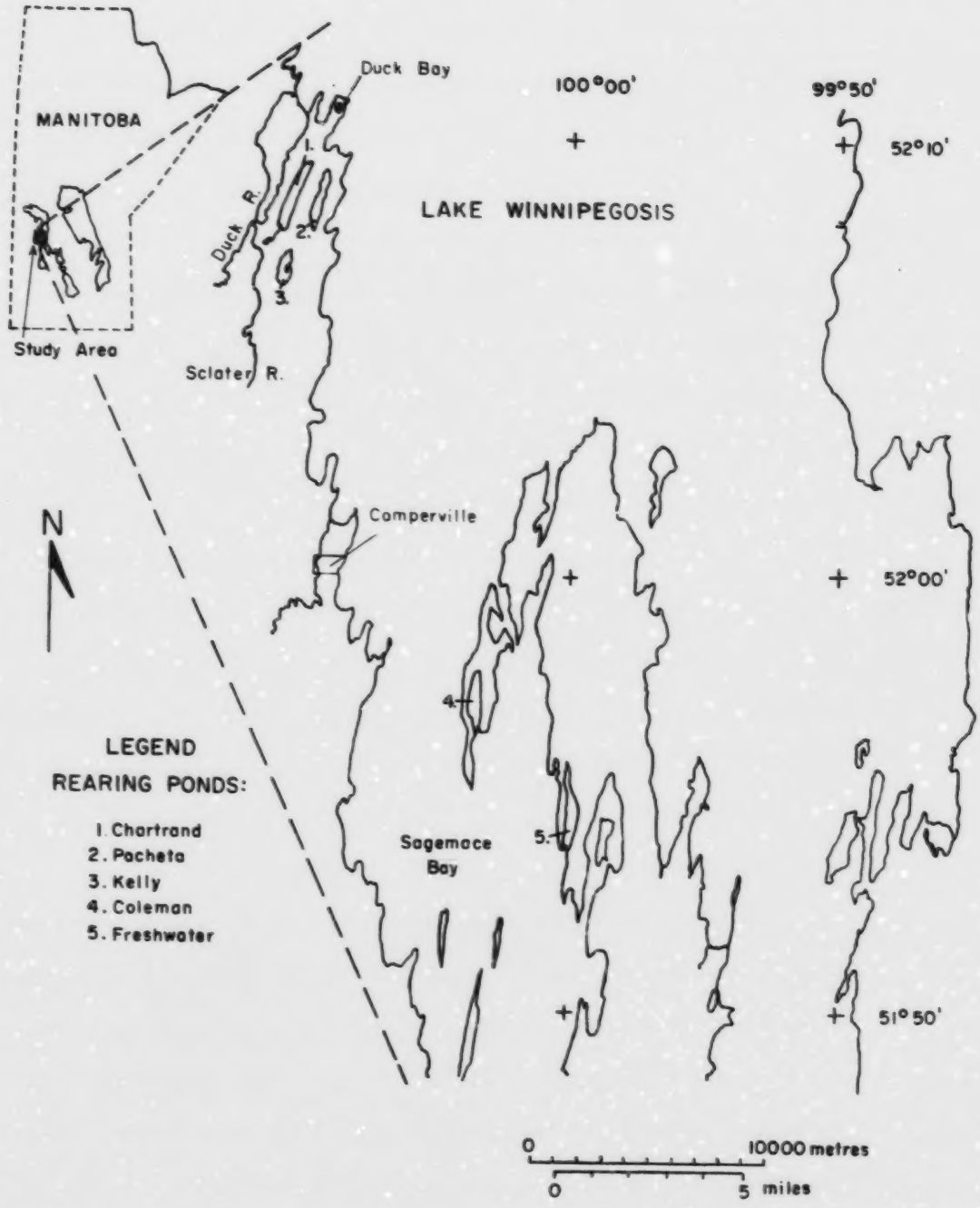

Fig. 2. Location of five rearing ponds in the Sagemace Bay - Duck Bay study area of Lake Winnipegosis.

Marked walleye fingerlings were released from the rearing ponds each year to provide a basis for the estimation of the rearing pond contribution to the lake population and the Lake Winnipegosis commercial catches. Regular monitoring for marked walleye in the commercial fishery was begun in 1980, while otter trawling and beach seining for younger walleyes was started in 1979. Results of the 1978 and 1979 studies of food, growth and survival of rearing pond walleyes were reported by Gillies and Green (1980) and Green (1980).

This report presents food, growth, survival and release data collected from the walleye rearing ponds in 1980 and 1981. Some comparisons with the 1978 and 1979 data are made. Preliminary data on marked walleye recoveries from commercial catch monitoring, otter trawling and beach seining are also presented.

METHODS

Sampling methods employed in the assessment of the Lake Winnipegosis walleye rearing ponds were similar to those described by Green (1980) and Gillies and Green (1980). In 1980 and 1981, walleye samples were collected bi-weekly from Coleman Pond. Because of the presence of pike, Freshwater Pond was not used in 1980. Increased sampling was therefore done on Kelly Pond; bi-weekly samples were taken in 1980. In 1981, Freshwater Pond was sampled on a bi-weekly basis and Kelly Pond was sampled every four weeks. Pacheta and Chartrand ponds were not stocked in 1980 and 1981 because of low water and vandalism problems.

In 1978 to 1980, the analysis of walleye stomach contents consisted only of identification and counting the various food items. Since results were biased by the larger food organisms, percentage estimates of the stomach content volumes were made. This analysis involved estimating the proportion of a food type compared to the total amount of food present in each stomach. This method did not allow direct comparisons between individuals since consideration was not given to the relative fullness of stomachs. Actual stomach volumes hadn't been measured. If a stomach contained some food, regardless of the actual amount, it was considered 100 percent full. Essentially, stomach samples were considered to contain equal amounts of food.

Special efforts to recover spray marked walleyes from Lake Winnipegosis were initiated in 1979. Recovery efforts involved beach seining, otter trawling and routine monitoring of the commercial fishermen's walleye catches. Beach seining and otter trawling were conducted primarily in the Sagemace Bay area (Fig. 3). Some trawling and seining was done in the area north of Duck Bay and south of Birch Island (Fig. 3 inset). Trawling was conducted from a 22 foot boat. Trawl tows were generally 20 or 40 minutes depending on the distance between landmark reference points. Tows were made at approximately 6 km h^{-1} so that the trawl net would fish on the bottom. An otter trawl with a 4.88 m (16 ft.) opening was used. Mesh size of the cod end liner was 64 mm (bar measure). Seining was done with a 2.4 x 15.0 m beach seine with a mesh size of 64 mm (bar measure). All seining was done within 30 m of shore.

Monitoring of commercial catches for spray marked walleye was done routinely during the summer fishing season (approximately July 20 - September 15). Boxes of walleye were selected at random from various fishermen's catches. Each box of walleye was dumped onto a "black light" table. The top of this table was enclosed in black polyethylene sheeting which blocked out most light. About 1.0 m above the table top were two ultraviolet tube lamps (Fig. 4). Each tube was approximately 61 cm long. A short curtain of polyethylene was suspended in

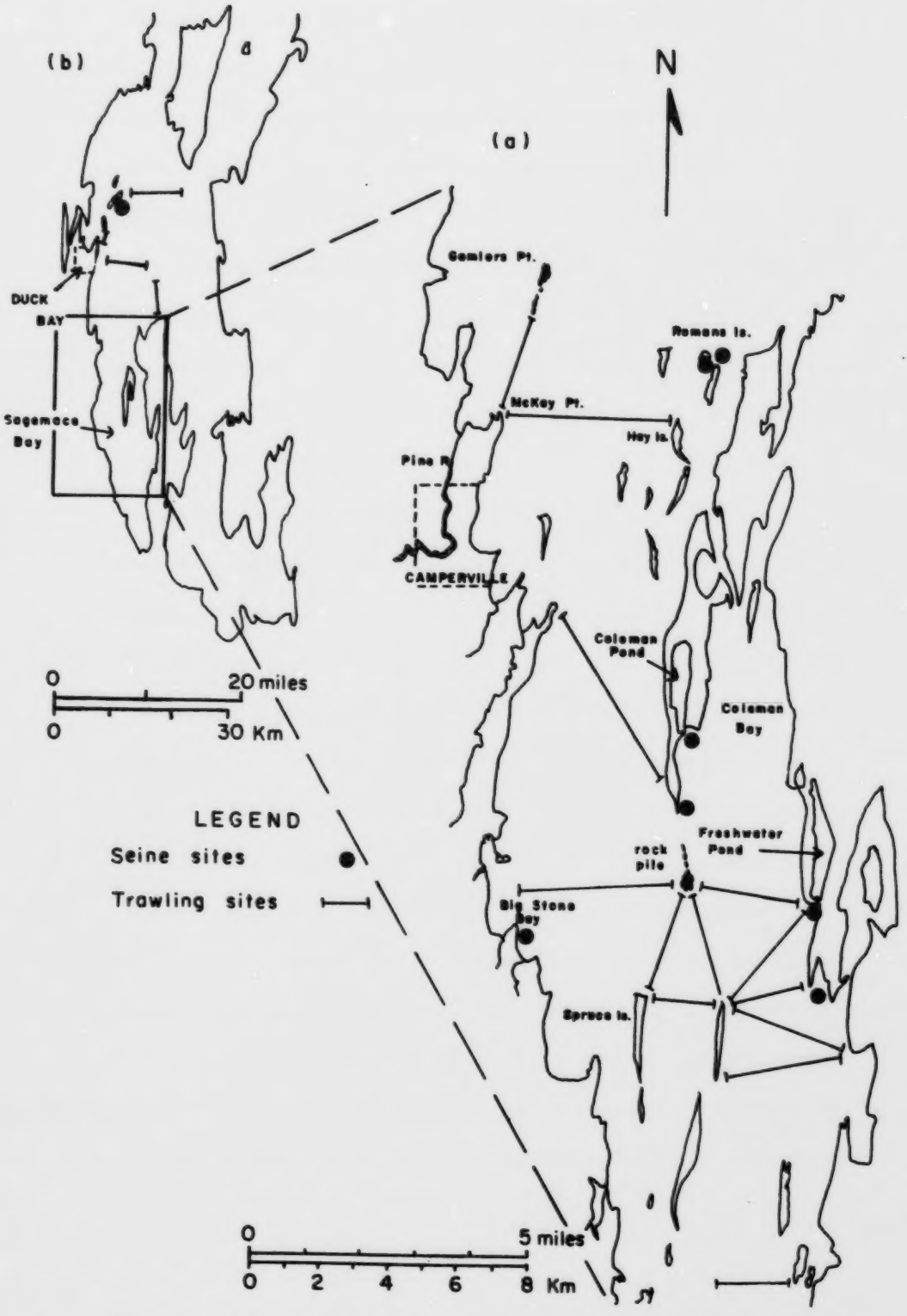

Fig. 3. (a) Sagemace Bay area where the majority of trawling and seining was done.
(b) Portion of Lake Winnipegosis where trawling and beach seines were conducted other than in Sagemace Bay.

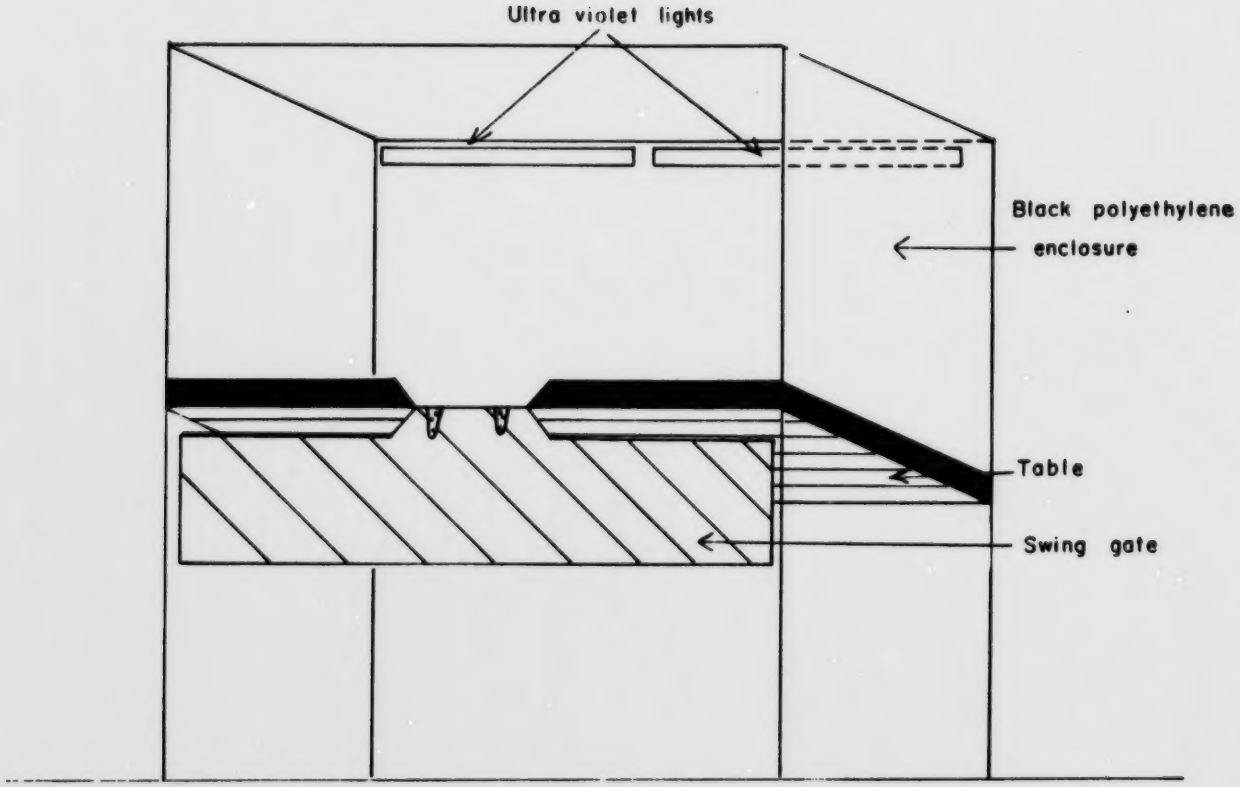

Fig. 4. Ultra-violet light table design used for checking walleyes caught by commercial fishermen.

front of the lights to prevent any eye damage to the observers. The ultraviolet light illuminated any fluorescent dye that might be embedded in the walleye. Each walleye placed under the U/V light was thoroughly inspected on all sides for possible marks. Any marks that were detected were rubbed to determine if the dye was embedded or whether the mark resulted from some contamination. Fluorescent material from paint, from the fish itself or carried on the observer's clothing sometimes contaminated the fish.

All walleye caught by otter trawling were also examined for spray markings. These samples were checked in a darkened area using a hand held U/V lamp.

To determine stocking densities of walleye plantings in the rearing ponds water volumes were used. Water volumes for Coleman and Freshwater ponds were determined using the mean water level readings for Lake Winnipegosis[1], surface areas calculated from aerial photographs and contour intervals (Campbell and Rowse 1980) that were drawn from hand line soundings in 1977. Some adjustments were made to the area covered by the 2.0 m contour on Coleman Pond and by the 1.0 and 1.5 m contours on Freshwater Pond. Air photos[2] with a scale 1:5,280 were used to determine surface area. Surface areas were measured using a Hewlett-Packard

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1 Province of Manitoba, Department of Natural Resources, Water Resources Branch.

2 Canada Department of Energy, Mines and Resources, Air Photo Division.

9100 B computer and a 9107 B digitizer. Mean Lake Winnipegosis water levels for May through October were used to determine a seasonal water level for the rearing ponds. Coleman and Freshwater pond water levels were governed by and generally the same as Lake Winnipegosis water levels. The seasonal mean level for each year was compared to the 1981 level which was the lowest during the four years, 1978 - 1981. The differences between the 1981 seasonal mean and the 1978 - 1980 seasonal means were found. These differences were used in adjusting volume determinations. Since the ponds were not sounded or photographed annually, the shoreline perimeters were assumed to remain constant. Volume determinations are therefore not precise, but are relative from year to year.

RESULTS

Pond Stocking

Coleman and Freshwater ponds were stocked with walleye fry hatched from measured quantities of eyed eggs that were placed in floating cages. One day old walleye fry were released into Coleman and Freshwater ponds on May 14, 1980, into Coleman Pond on May 20, 1981 and into Freshwater Pond on May 21, 1981. Numbers of fry released are presented in Table 1. There was evident egg and fry mortality within the egg cages set in Coleman and Freshwater ponds during 1980. Total mortality (eggs and fry combined) for 1980 was 29 percent in Coleman Pond and 24 percent in Freshwater Pond (Table 2). The highest mortality was among eggs in Coleman Pond and among fry in Freshwater Pond.

Table 1. Walleye rearing pond stocking rates, 1980 and 1981.

Location	Number stocked		Area	Volume 1. (m^3)		no./ha		no./100m^3	
	1980	1981	(ha)	1980	1981	1980	1981	1980	1981
Coleman	241,000	220,000	105	670,586	476,122	2295	2095	36	46
Freshwater	353,000	660,000	104	621,254	427,254	3394	6346	57	154
Kelly[2]	250,000	500,000	65	-	-	3846	3077	-	-

1 estimates calculated using mean weekly water levels from Lake Winnipegosis.

2 number stocked estimated by visual observation.

Table 2. Mortality of caged walleye eggs and fry in Coleman and Freshwater ponds before stocking; 1980 and 1981. Percent represents percentage mortality to the number originally stocked.

Location	Eyed eggs				Walleye fry				Total			
	1980		1981		1980		1981		1980		1981	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Coleman	53,100	27	nil	-	5,100	2	nil	-	58,200[1]	29	nil	-
Freshwater	58,500	10	nil	-	86,600	14	660,000	100	145,100	24	660,000[2]	100

1 100,000 caged fry from Freshwater transferred to Coleman Pond.

2 Total mortality in Freshwater Pond was replaced with an equal number of new eggs which hatched with no mortality.

Kelly Pond was stocked with four day old walleye fry that had been hatched at the Duck Bay Hatchery. The planting occurred on May 13, 1980 and May 25, 1981. Stocking rates determined for Kelly Pond (Table 1) are questionable, since numbers planted were estimated by eye.

Food

Micro-crustaceans were the principal food types selected by rearing pond walleyes within 15 to 20 days after hatching. At this time the fry were 13 to 20 mm mean length. Cladocerans were commonly found in most walleye stomachs from Coleman and Freshwater, while copepods were of lesser importance (Figs. 5 to 7). By contrast, copepods were of more importance than cladocerans to Kelly Pond walleye during the first 16 to 30 days (Figs. 8 and 9).

At about 30 days of age when the walleye had attained lengths of 26 to 35 mm, their diet began to diversify. There was some change from micro-crustaceans to larger organisms such as chironomids, dipteran pupae and even forage fish. However, most walleye still exhibited a tendency to select cladocerans and copepods over other food items at this time. By 40 to 45 days, walleye fry were generally feeding on larger food. An exception to this behaviour occurred in Coleman Pond during 1978 and 1981. Micro-crustaceans were observed in as many as 30 to 40 percent of the Coleman Pond walleye stomachs that were examined from 85 and 114 day old walleye in 1978 and 1981, respectively, (Figs. 5 and 6).

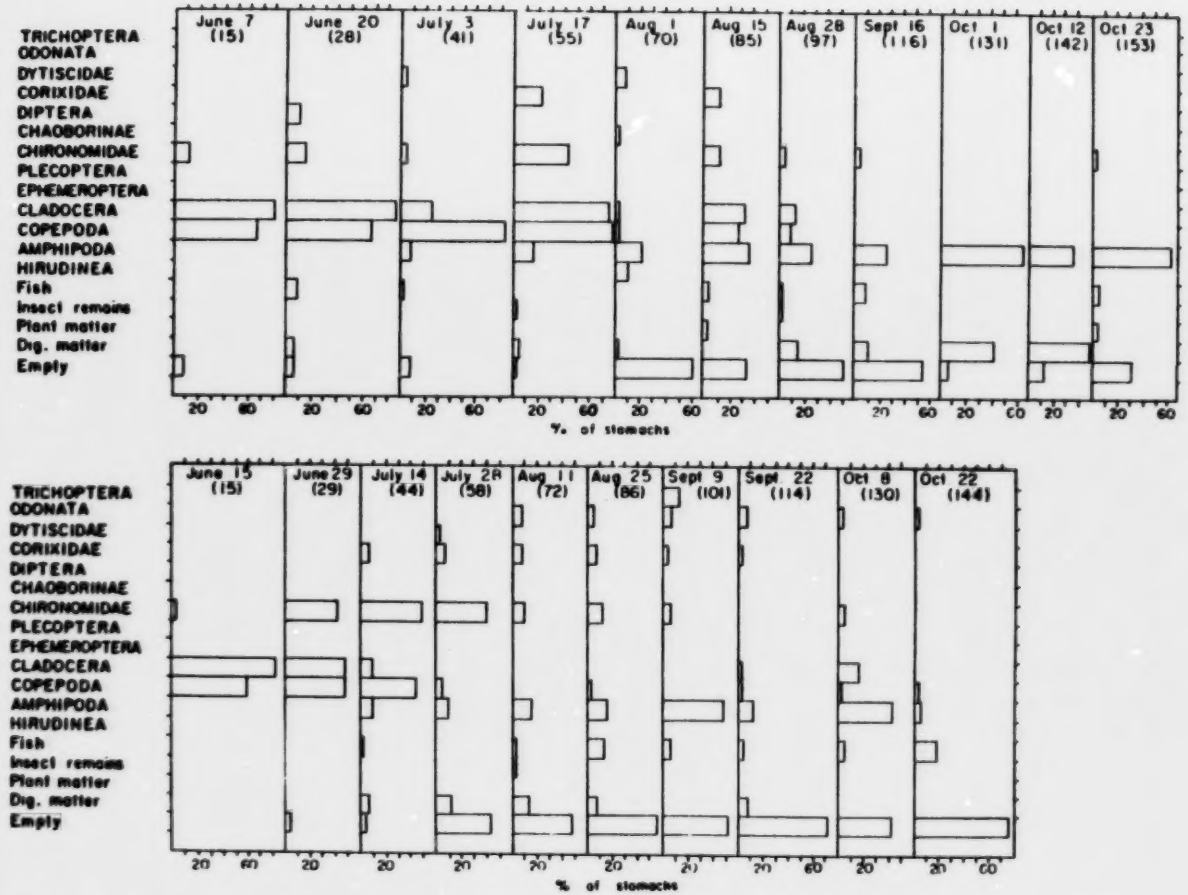
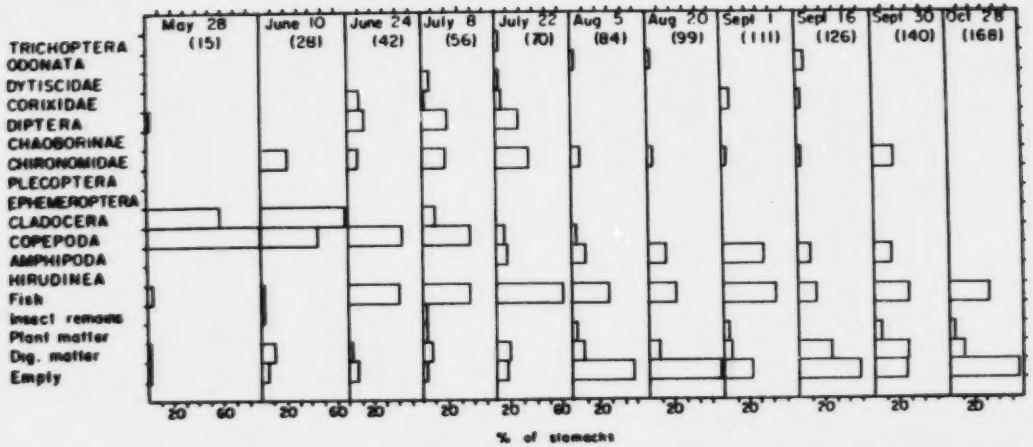


Fig. 5. Percent of walleye stomachs containing particular food items per sample period from Coleman Pond, 1978 and 1979. Number of days from hatching in parenthesis.

1980



1981

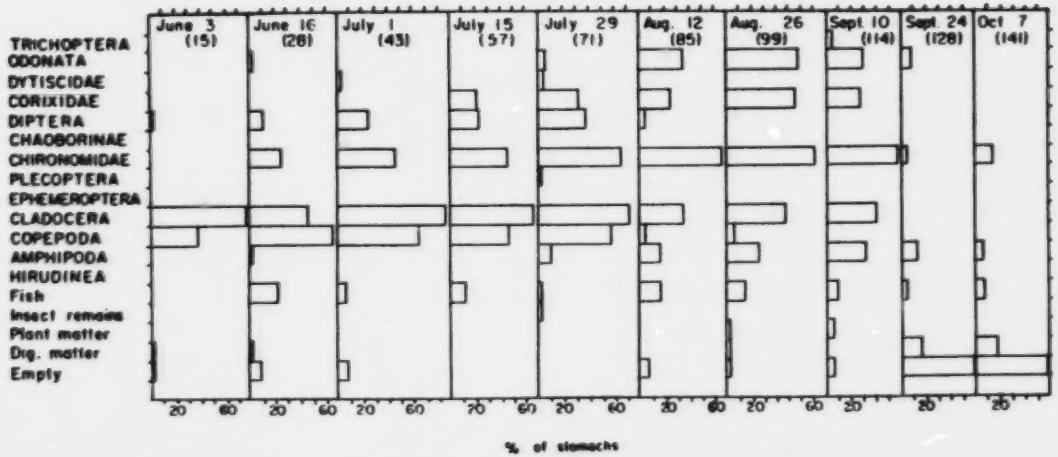


Fig. 6. Percent of walleye stomachs containing particular food items per sample period from Coleman Pond, 1980 and 1981. Number of days from hatching in parenthesis.

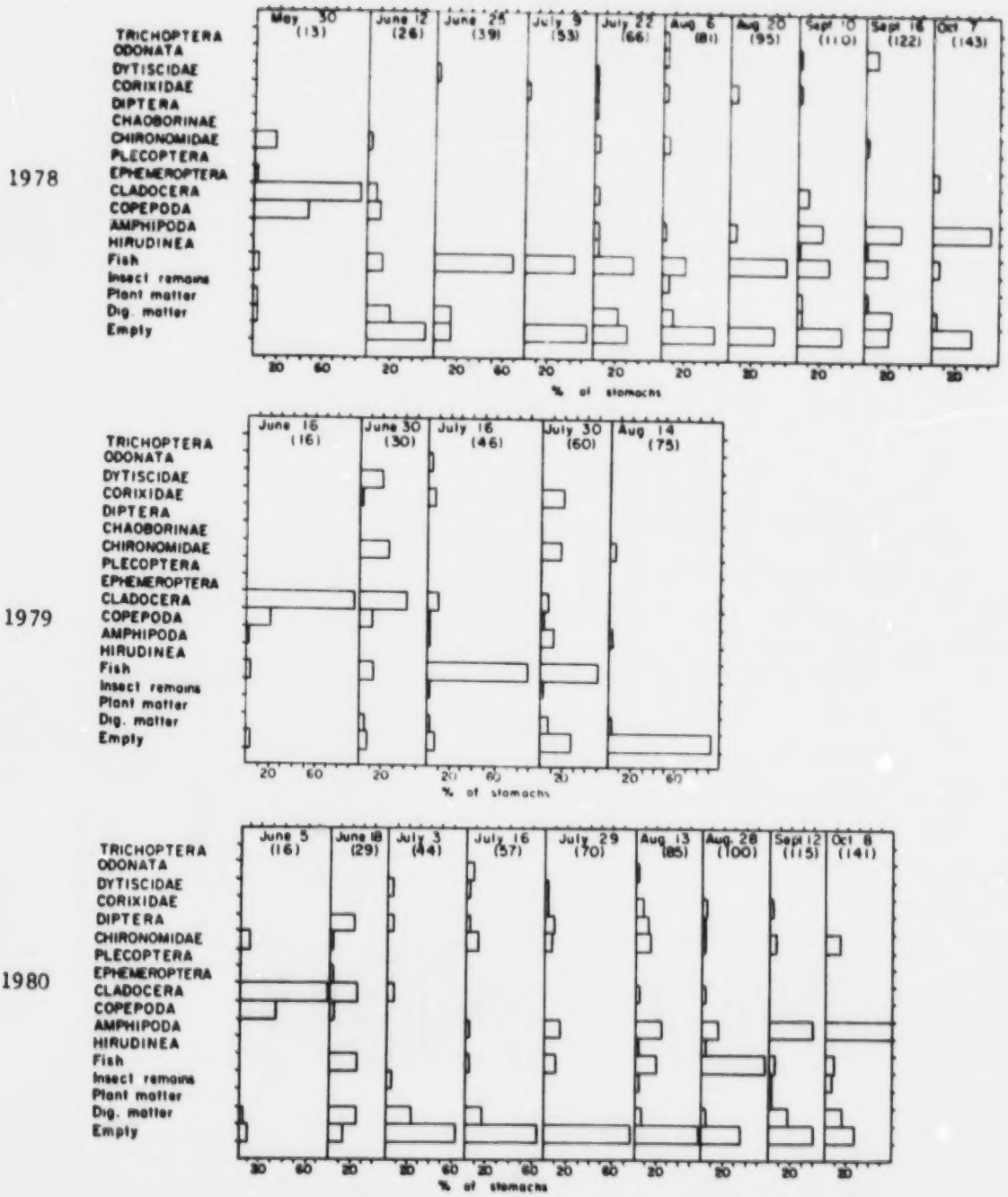
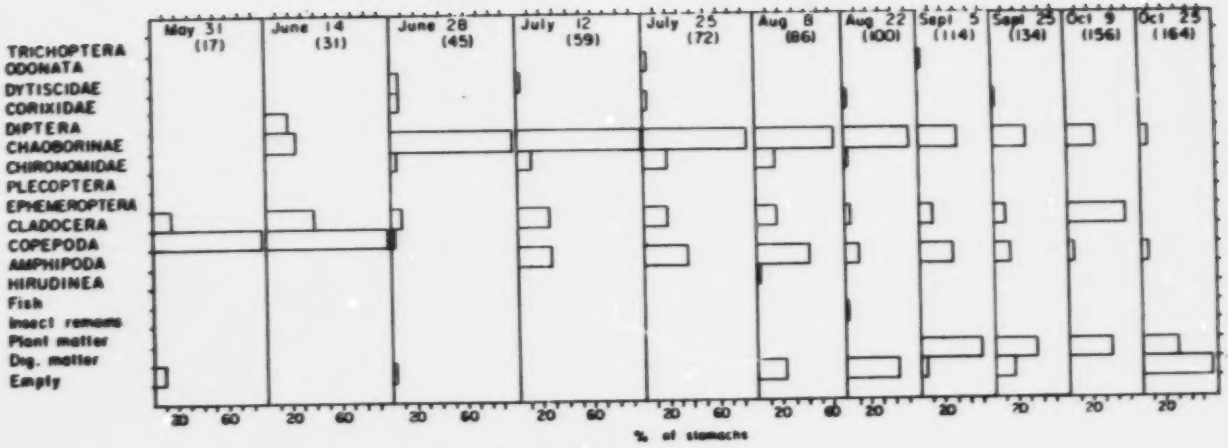


Fig. 7. Percent of walleye stomachs containing particular food items per sample period from Freshwater Pond, 1978, 1979 and 1981. Number of days from hatching in parenthesis.

1978



1979

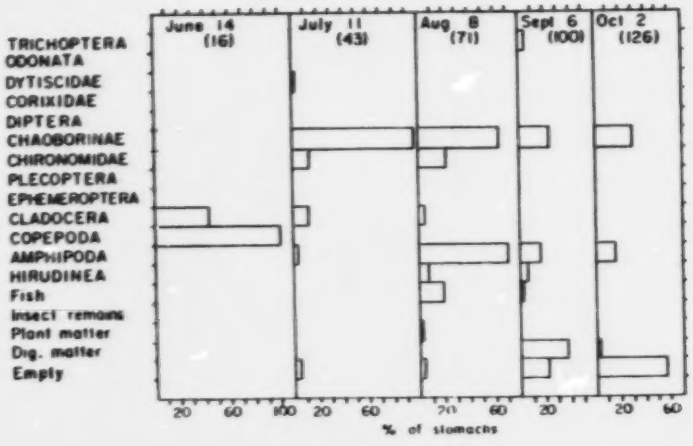


Fig. 8. Percent of walleye stomachs containing particular food items per sample period from Kelly Pond, 1978 and 1979. Number of days from hatching in parenthesis.

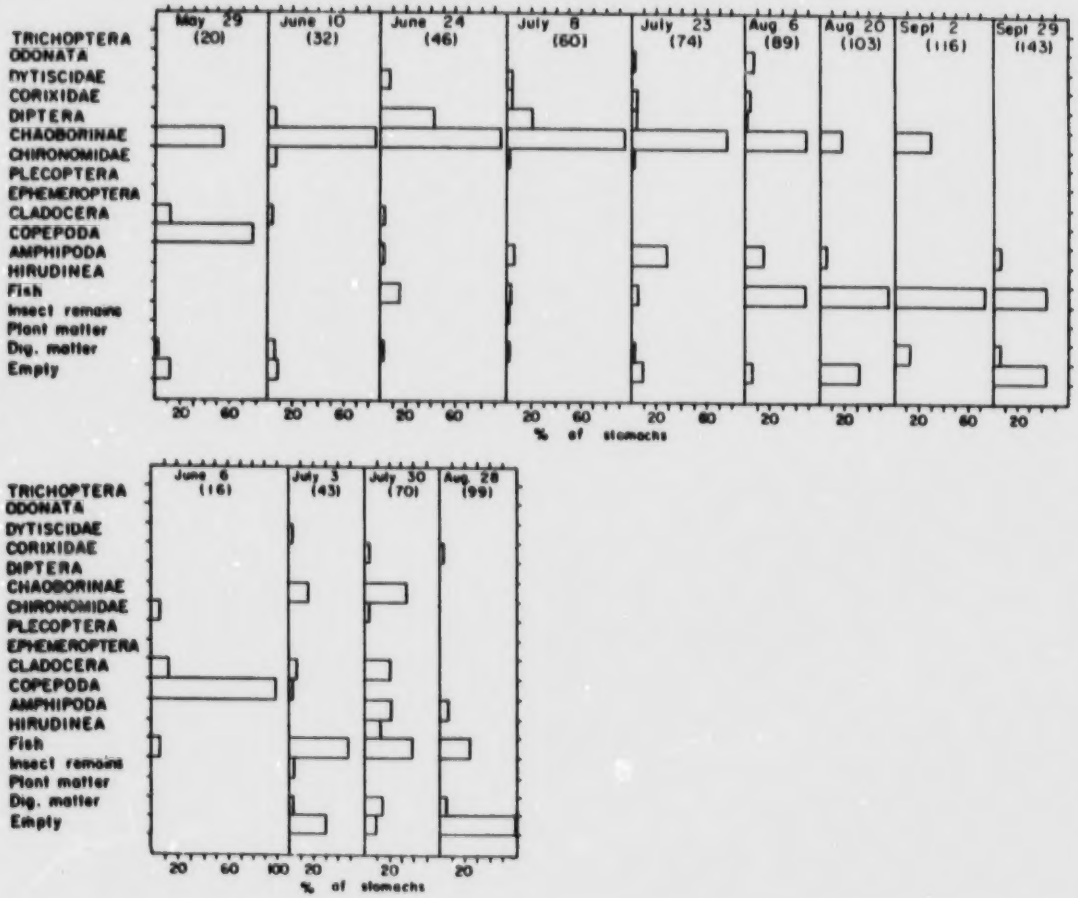


Fig. 9. Percent of walleye stomachs containing particular food items per sample period from Kelly Pond, 1980 and 1981. Number of days from hatching in parenthesis.

The choice of a specific food type, other than micro-crustaceans, was never consistent from year to year by walleye in the same rearing pond. In Coleman Pond, forage fish were found in more walleye stomachs than other food items during 1980. In 1981, the greatest percentage of walleye usually chose chironomids, while the numbers of walleyes consuming forage fish had declined significantly (Fig. 6). The most consistent conversion from a diet of micro-crustaceans to another food type took place in Kelly Pond. There, between 90 to 100 percent of the walleyes 40 to 45 days of age were choosing *Chaoborus*. The majority of walleyes in Kelly Pond fed on *Chaoborus* from late June until late August (90 to 100 days). The only exception occurred in 1981, when forage fish appeared to be more important (Fig. 9). However, Kelly Pond walleyes still consumed substantial amounts of *Chaoborus* in July, 1981.

Amphipods, even though they appeared to be abundant in all rearing ponds throughout the entire openwater season, were usually selected by the walleye fry from only mid-July (approximately 60 days after hatching) to October in all rearing ponds.

Food items that were generally eaten by most walleye and commonly consumed in all rearing ponds were cladocerans, copepods, amphipods, chironomids and forage fish. The incidence of other food types such as trichopterans, Odonata nymphs, corixids, plecopterans, etc., varied between rearing pond and years. The frequency of appearance of many of the latter food items was usually minimal, occurring in less than five percent of the stomachs

examined for any one sample period. One exception occurred in Coleman Pond in 1981, when corixids were found in 20 to 56 percent of the stomachs examined between July 15 and September 10. Odonata nymphs were observed in 30 to 60 percent of the walleye stomachs sampled from August 12 to September 10 (Fig. 6).

The number of empty walleye stomachs observed from all ponds increased during July and August. This was primarily attributable to the increased length of trapnet sets required to obtain walleye samples. The duration of trap net sets was about 4 h in May, June and early July. Overnight sets (24 h) were necessary after mid-July, if the required sample size was to be obtained. In 1981, walleye samples collected from Coleman Pond were captured in seines from June until September 10. Using this collecting method few empty stomachs were encountered in the samples. After September 10, seining was no longer effective in capturing walleye from Coleman Pond, and samples were taken from a trap net attached to the release culvert. Walleye samples collected from the release net on September 24 and October 7 showed as many as 60 percent of the stomach empty (Fig. 6). Seining was ineffective in capturing adequate samples of walleye from the other rearing ponds.

The diet of walleye in some rearing ponds seemed unique to the pond. Detailed data on food preferences are therefore presented separately for each pond. These data for 1978 and 1979 are presented by Gillies and Green (1980). The following text basically presents the 1980 and 1981 data on walleye food habits, but some comparisons are made with the 1978 and 1979 results.

Coleman Pond - Bi-weekly samples indicated that micro-crustaceans were found in the highest percentage of walleye stomachs during May, June and July. In 1980, cladocerans and copepods became less important towards the end of July, when the walleye were about 70 days old, and completely disappeared from the diet in August (Fig. 6, Appendix 1a). Copepods were present in 90 percent of the stomachs examined in May, 38 percent in July and only 2 percent in August. Cladocerans disappeared entirely from the diet by late July. A greater proportion of the walleye were choosing forage fish and chironomids as the incidence of micro-crustaceans decreased. Chironomids and other dipterans were mainly selected in late June and July and then declined in importance during August and later. Walleye chose forage fish over all other food types from July to October (Fig. 6).

Forage fish were not as prominent in the walleye diet during 1981. Rather, chironomids were more prevalent. They were consumed by 26 to 72 percent of the walleye sampled from June 16 (after 28 days) to September 10 (114 days). Micro-crustaceans also appeared to be more important to Coleman Pond walleye in 1981 than in 1980. Forty percent of the stomachs examined on September 10, 1981, still contained cladocerans and the incidence of cladocerans from June 3 through to September 10 was generally 40 percent or more (Fig. 6). Odonata nymphs and corixids were present in a greater percentage of stomach samples taken during 1981 than in the previous three years. As previously noted, corixids were found in as many as 20 to 56 percent of the walleye stomachs sampled from July 15 to September 10, 1981 (Appendix 1b).

The highest proportion of walleye stomachs containing corixids from a sample period in previous years was about 10 percent.

Amphipods were not taken by walleyes until late July when the fish were about 70 days old (Fig. 6). In 1978 and 1979, walleye began selecting amphipods by early to mid-July (at age 40 - 45 days). As in 1980 and 1981, however, the highest incidence of amphipods in walleye stomachs occurred from August to the end of summer (Fig. 5).

Food items consumed in the greatest numbers from May to the end of July were copepods and cladocerans. In 1981, cladocerans comprised the highest numbers that were eaten to as late as September 10. Forage fish and amphipods were taken in greatest numbers from August to October in 1980, while higher numbers of chironomids and amphipods were consumed from September 24 to October in 1981 (Appendices 2a and 2b).

In 1981, percentage estimates of food volume also indicated that cladocerans were an important diet item from June to September. Cladocerans made up as much as 67 percent of the food volume consumed on June 3 and still comprised 21.8 percent of the food volume on September 10 (Appendix 3a). Except for the June 16 sample, cladocerans formed the major proportion of the food volume observed in walleye samples taken from June 3 until July 29. On June 16, copepods contributed 36 percent of the food volume. Later in the summer, August and September, chironomids formed the largest percentage of the food volume.

An examination of the frequency of occurrence of food items on a seasonal basis indicated that forage fish and copepods in 1980 and cladocerans and chironomids in 1981 were the most commonly selected food organisms (Fig. 10, Appendix 4a). Micro-crustaceans were certainly important to the walleye between 14 and 30 days of age. Their importance later in the season depended upon the year. Variability in the occurrences of different food organisms from year to year suggests that availability of the various organism was probably a major factor in the food preferences exhibited by the young walleye.

Freshwater Pond - Cladocerans and copepods were the two principal food items found in most walleye stomachs examined from Freshwater Pond on June 5, 1981 (16 days old). Unlike Coleman Pond walleye, micro-crustaceans were of lesser importance by 26 to 30 days of age (Fig. 7). By this time a wider variety of larger food organisms was being selected.

In June, 1981, forage fish, cladocerans and dipterans were found in approximately 24 percent of the stomachs sampled (Appendix 1c). A high incidence of empty stomachs prevented the evaluation of walleye food preferences in July,1981. However, in August most of the stomachs which contained food had forage fish and amphipods. As in Coleman Pond, amphipods began appearing in an increasing number of walleye stomachs in late July and were most common in September and October (Fig. 7).

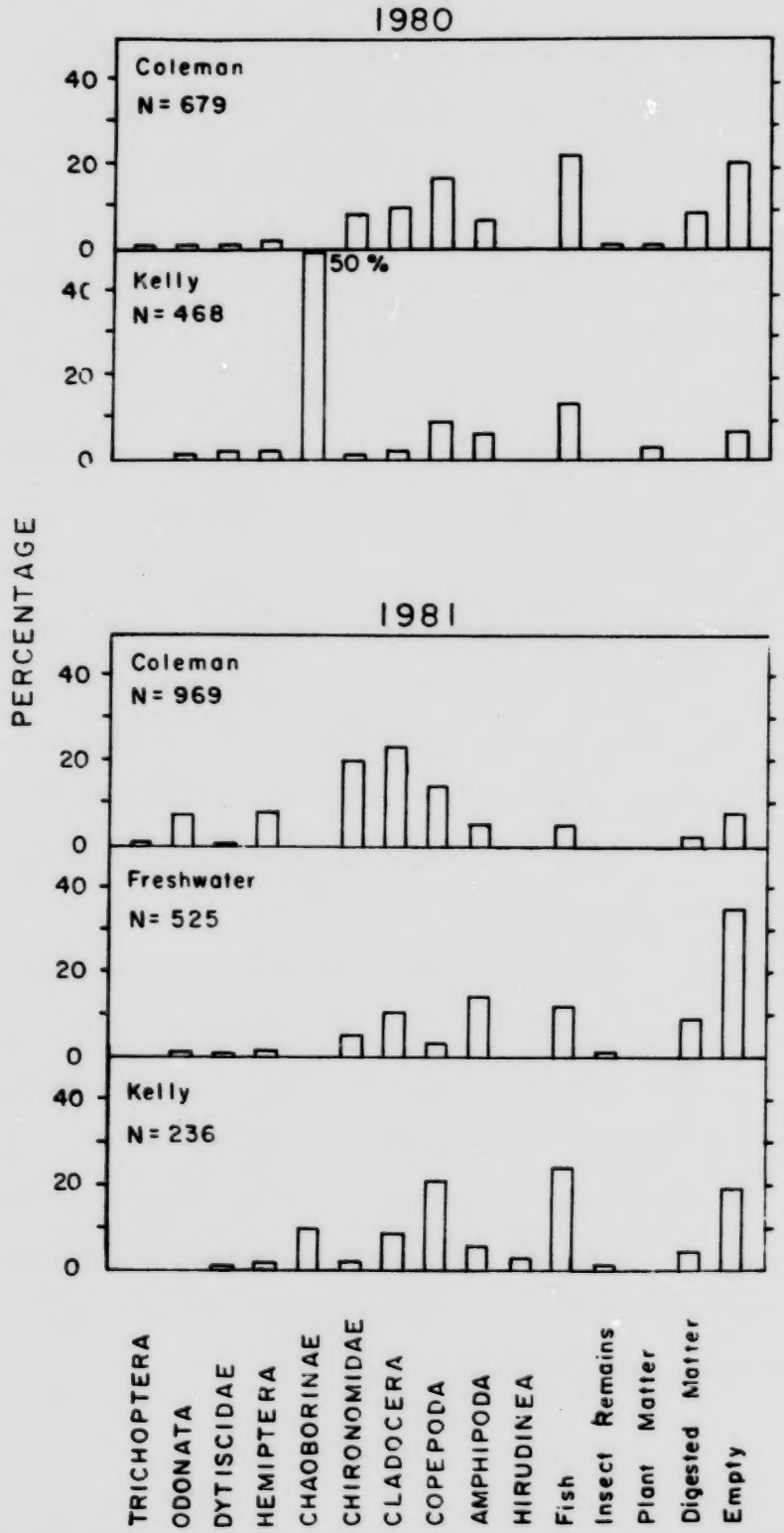


Fig. 10. The percentage occurrence of individual food items in the gut in relation to all food items eaten by walleyes in each Lake Winnipegosis rearing pond, 1980 and 1981. N = total number of occurrences observed for all food items.

Food types eaten in the largest quantity were cladocerans during June and early July, chironomids in mid and late July, and amphipods for the remainder of the season except in August. In the August 28 sample, forage fish formed 48.3 percent of the numbers of organisms eaten while amphipods contributed 20.7 percent (Appendix 2c).

Estimates of food volume showed that micro-crustaceans contributed the highest percentage (71.8%) of stomach contents on June 5 (Appendix 3b). On June 18, however, forage fish contributed the largest proportion of the food volume even though fish and cladocerans were found in an equal number of stomachs. From June 18 to August 28, most of the identifiable stomach content volume was forage fish remains. Amphipods remains were most voluminous in the stomach content from September 12 to October 28 (Appendix 3b).

A summation of the 1981 results on a seasonal basis showed that the greatest numbers of occurrences were by amphipods (14.3%), forage fish (11.8%) and cladocerans (10.7%) (Appendix 4b). The above three items along with chironomids were the most important food in the diet of Freshwater Pond walleye in 1981 (Fig. 10).

Kelly Pond - Copepods were chosen by the majority of Kelly Pond walleye within 16 to 20 days after hatching. Copepods were observed in 78 percent of walleye stomachs in the May 29, 1980 sample and 100 percent in the June 6, 1981 sample (Fig. 9).

Chaoborus larvae predominated the stomach content of Kelly Pond walleye after 30 days and were a common food item throughout much of the summer season in all sample years. In 1980, *Chaoborus* was observed in as many 96 to 50 percent of the walleye stomachs examined from June 10 to August 6 (Appendix 1d). In August and September, 1980, most of the Kelly Pond walleye began selecting forage fish instead of *Chaoborus* (Fig. 9). The early predominance of *Chaoborus* did not occur in 1981. *Chaoborus* were noted in as many as 32 percent of the stomachs examined on July 30, 1981. In this same sample, however, forage fish were present in 38 percent of the stomachs.

As in Coleman and Freshwater ponds, a greater number of Kelly Pond walleye began taking amphipods from mid-July to the end of the summer season. The selection of amphipods was more evident in 1978 and 1979 when forage fish were not as heavily utilized. In 1980 and 1981, Kelly Pond walleye were feeding more extensively on forage fish (Figs. 8 and 9).

Food items consumed in greatest quantities by Kelly Pond walleye were copepods on May 29, 1980 and June 6, 1981. In 1980 after the walleye had reached 30 days of age, greater numbers of *Chaoborus* than of any other food item were consumed throughout the summer. The only exception was on September 29 (143 days) when forage fish contributed 63.6 percent of the total number of food organisms consumed (Appendix 2d). In 1981, most of the numbers

consumed at the end of July and in August were *Chaoborus* larvae and forage fish, respectively.

Food types contributing most to the percent of food volume estimates in 1981 were copepods (90.3%) in June and forage fish during the remainder of the season. *Chaoborus* formed as much as 23.6 percent of the food volume in the July 30 sample. Even though fewer numbers of forage fish were consumed on July 30, they nevertheless formed the greatest percentage of food volume at this time. Forage fish contributed as much as 37.2 percent of the food volume on July 30 and 67 percent on July 3 (Appendix 3c).

The seasonal summary of stomach contents for Kelly Pond indicated that the greatest number of occurrences were by *Chaoborus* larvae (50%), forage fish (12.8%) and copepods (8.3%) in 1980 (Fig. 10, Appendix 4a). The same three food items were also the most prevalent in 1981, but their order of importance was changed. Forage fish were more abundant and *Chaoborus* larvae were least numerous in the 1981 samples (Fig. 10).

Growth

Length and weight measurements of rearing pond walleye were obtained approximately every two weeks beginning when the fish were about 14 days old. Age was represented by the number of

days following hatching. Walleye growth during 1980 and 1981 showed trends similar to the 1978 and 1979 growth reported by Gillies and Green (1980). The average growth of walleye tended to vary between ponds and between years. Growth was relatively rapid from the time of hatching and tapered off in the late summer.

During 1980 and 1981, walleye attained average lengths of 62 to 68 mm at 56 to 60 days of age (Tables 3 and 4, Fig. 11). Sixty days of age occurred near mid-July in 1980 and about a week later in July, 1981. At about mid to late September (120 to 130 days) the release of walleye fingerlings from the rearing ponds was begun. The average fork length of walleyes at this time was usually 100 mm or more. Coleman Pond walleye in 1980 had a mean fork length of 122.4 mm and a mean weight of 21.3 g at 140 days. Similar age walleye in 1981 averaged only 113 mm in fork length and 13.3 g in weight (Tables 3 and 4). The longest walleye released from the rearing ponds in 1980 and 1981 were 164 and 157 mm. respectively (Fig. 12). These fish were from Coleman Pond.

Walleye released from Freshwater and Kelly ponds were slightly smaller than those from Coleman Pond. Freshwater and Kelly pond walleye were usually between 100 and 110 mm average fork length. At any given time during 1980 and 1981, Coleman Pond walleye were generally larger in both length and weight than Freshwater and Kelly pond walleye (Fig. 11). The largest walleye released from Freshwater and Kelly ponds were 140 and 148 mm, respectively (Fig. 12).

Table 3 . The mean fork lengths (mm) and mean weights (gm) of walleyes from Lake Winnipegosis rearing ponds, 1980.

Coleman				Freshwater				Kelly			
Date	Age (days)	fl.	wt.	Date	Age (days)	fl.	wt.	Date	Age (days)	fl.	wt.
May 28	15	19.0	0.08					May 29	20	18.6	0.07
June 10	28	33.8	0.40					June 10	32	30.2	0.31
June 24	42	53.0	1.52	June 24*	42	54,0	1.55	June 24	46	50.1	1.27
July 8	56	66.3	3.08					July 8	60	64.4	2.67
July 22	70	86.7	6.93					July 22	74	78.1	4.55
Aug. 5	84	95.2	8.37					Aug. 6	89	83.5	5.26
Aug. 20	99	115.5	15.86					Aug. 20	103	97.3	8.73
Sept. 1	111	118.2	16.17					Sept. 2	116	109.0	12.44
Sept. 16	126	120.3	17.19					Sept. 20	134	102.9	10.44
Sept. 30	140	122.4	21.27					Sept. 29	143	109.4	18.39
Oct. 28	168	118.6	16.02					Oct. 13	157	124.2	18.16

* Sample consisted of 2 walleye only. Data not collected from Freshwater because of pike presence in pond.

Table 4. The mean fork lengths(mm) and mean weights (gm) of walleyes in Lake Winnipegosis rearing ponds, 1981.

Coleman				Freshwater				Kelly			
Date	Age (days)	fl.	wt.	Date	Age (days)	fl.	wt.	Date	Age (days)	fl.	wt.
June 3	15	15.0	0.03	June 5	16	15.9	0.04	June 6	16	13.6	0.02
June 16	28	28.9	0.27	June 18	29	27.6	0.21				
July 1	43	49.4	1.23	July 3	44	45.7	0.85	July 3	43	49.7	1.21
July 15	57	68.7	3.69	July 16	57	61.9	2.46				
July 29	71	80.6	5.56	July 29	70	73.8	3.82	July 30	70	86.1	6.31
Aug. 12	85	92.6	8.33	Aug. 13	85	81 9	5.14				
Aug. 26	99	101.5	9.98	Aug. 28	100	93.5	8.02	Aug. 28	99	91.7	6.37
Sept.10	114	106.3	12.44	Sept.12	115	10u.6	10.30				
Sept.24	128	109.5	13.60	-		-	-				
Oct. 7	141	112.7	13.3	Oct. 8	141	102.7	10.23				

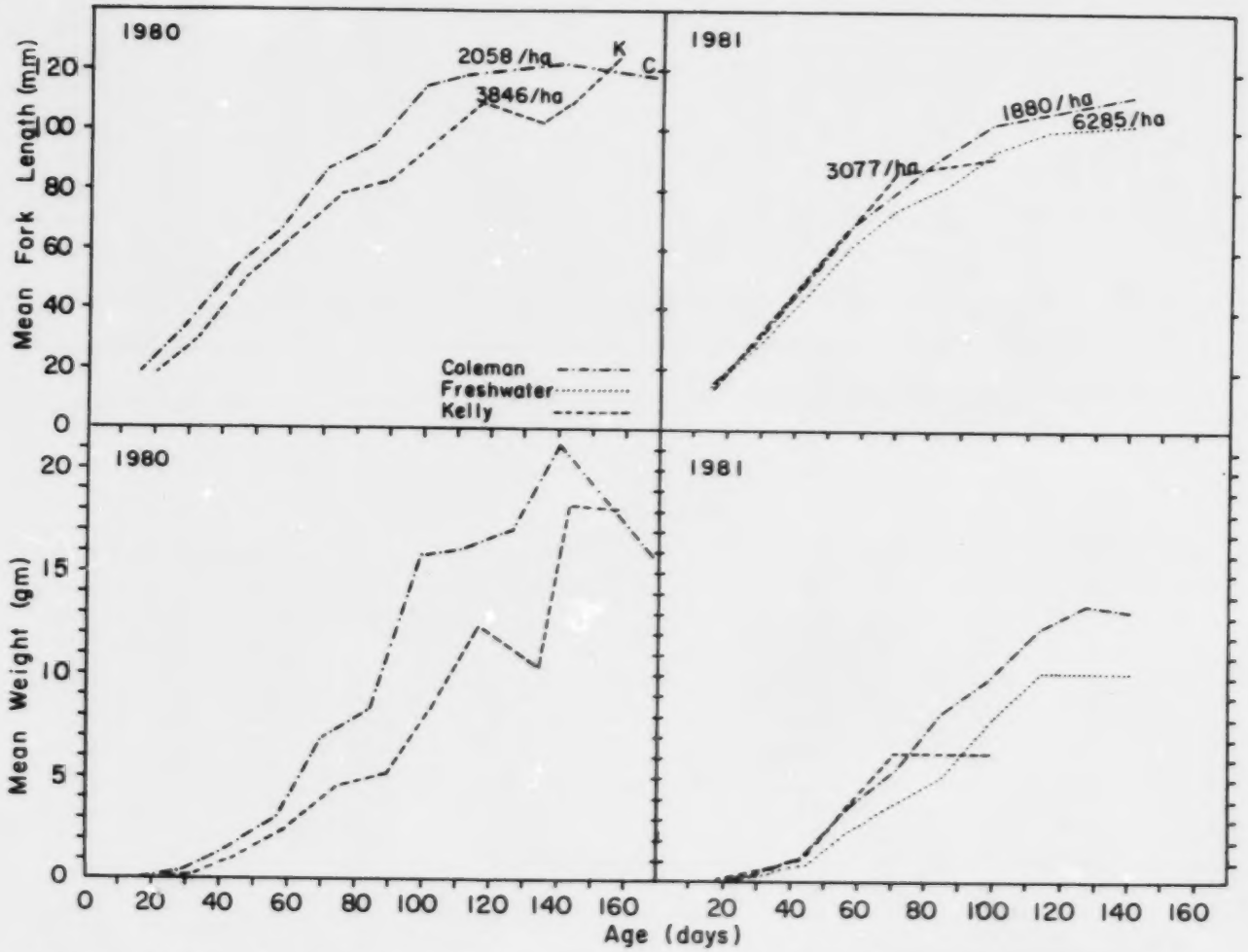


Fig. 11. Mean fork length and mean weight growth curves (with associated stocking rates of fry number/ha) of walleyes from Lake Winnipegosis rearing ponds, 1980 and 1981.

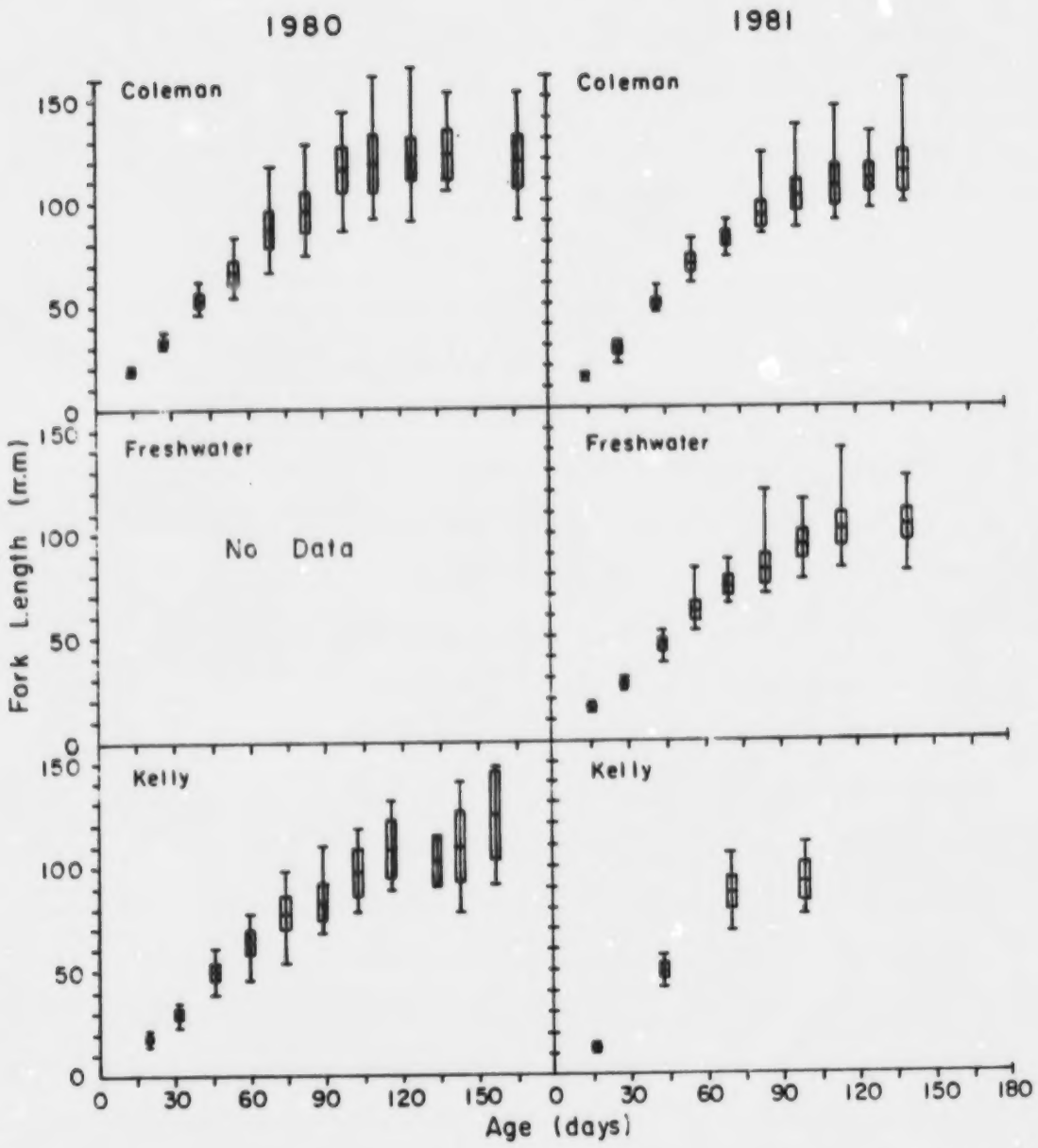


Fig. 12. Mean fork lengths (range and standard deviation) of walleyes from Lake Winnipegosis rearing ponds, 1980 and 1981.

Better average growth was found in Coleman Pond in 1980 than in 1981, whereas walleyes between 15 and 100 days of age in Kelly Pond grew faster in 1981 than in 1980 (Tables 3 and 4). Growth data for Kelly Pond walleye in 1981 after 100 days of age were not available because of early releases that year.

Size differences among walleye in the same rearing pond were small early in the growing season; i.e. from 15 to 30 days (Fig. 12). Later in the season the divergence between the largest walleye and the sample mean was as much as 45 mm. The greatest size difference between the smallest and largest walleye in a sample usually occurred after 100 days. In some samples, the larger walleye were almost twice the length of the smallest individuals.

The rapid growth which the walleye exhibited following hatching began to attenuate around 75 to 80 days in 1980 and 1981. Walleye growth in Coleman Pond during 1980 did not level off until about 105 days of age (Fig. 12). The flattening of growth curves appeared to coincide with the occurrence of bi-weekly length increments of less than 10 percent. Bi-weekly length increments that were less than 10 percent of the total summer's growth were commonly found after 85 - 100 days of age or between mid and late August (Tables 5 and 6).

An analysis of covariance ($P \leq 0.05$) simultaneously conducted on the slopes and elevations of the 1978 - 1981 length growth curves showed some significant differences for the comparisons

Table 5 . Length increments for walleyes from Lake Winnipegosis rearing ponds between sampling periods, 1980.

Coleman			Kelly		
Sampling period (days from stocking)	Increment gain (mm)	$\bar{x}$	Sampling period (days from stocking)	Increment gain (mm)	$\bar{x}$
15-28	14.8	14.9	20-32	11.6	11.0
29-42	19.2	19.3	33-46	19.9	18.8
43-56	13.3	13.4	47-60	14.3	13.5
57-70	20.4	20.5	61-74	13.7	13.0
71-84	8.5	8.5	75-89	5.4	5.1
85-99	20.3	20.4	90-103	13.8	13.0
100-111	2.7	2.7	104-116	11.7	11.1
112-126	2.1	2.1	117-134	-6.1	-5.8
127-140	2.1	2.1	135-143	6.5	6.1
141-168	-3.8	-3.8	144-157	15.0	12.3

Table 6 . Length increments for walleyes from Lake Winnipegosis rearing ponds between sampling periods, 1981.

Coleman			Freshwater			Kelly		
Sample period (days from stocking)	Increment gain (mm)	$\bar{x}$	Sample period (days from stocking)	Increment gain (mm)	$\bar{x}$	Sample period* (days from stocking)	Increment gain (mm)	$\bar{x}$
15-28	13.9	14.2	16-29	11.7	13.5	16-43	36.1	46.2
29-43	20.5	21.0	30-44	18.1	20.9			
44-57	19.3	19.8	45-57	16.2	18.7	44-70	36.4	46.6
58-71	11.9	12.2	58-70	11.9	13.7			
72-85	12.0	12.3	71-85	8.1	9.3	71-99	5.6	7.2
86-99	8.9	9.1	86-100	11.6	13.4			
100-114	4.8	4.9	101-115	7.1	8.2			
115-128	3.2	3.3	-	-				
129-141	3.2	3.3	116-141	2.1	2.4			

* sample period every four weeks as opposed to regular bi-weekly for Coleman and Freshwater ponds.

made (Table 7). Significant differences were found in the slopes of length growth curves for Coleman Pond walleye between years throughout the entire sampling period and for the period 15 - 71 days. Significant differences in elevation were noted for Kelly Pond walleye growth curves.

Walleye in rearing ponds stocked at lower rates (no. fry ha^{-1}) frequently achieved better growth than in ponds stocked at higher rates (Fig. 11). Since there were marked differences in pond water levels from year to year, walleye growth was also compared with stocking densities. Stocking density is the number of fry per 100 m^3. Mean seasonal (May - October) water level fluctuations were as much as 0.62 m (2.03 ft.) from the highest water year in 1979 to the lowest in 1981. Stocking densities could only be determined for Coleman and Freshwater ponds.

Linear regression analyses of 14 - 70 day old walleye from Coleman and Freshwater ponds all showed that a faster growth rate was experienced at a lower stocking density (Fig. 13). Growth throughout the season was also generally better with lower stocking densities (Fig. 14). An exception occurred in Coleman Pond in 1979. Good growth was experienced by Coleman Pond walleye up to 70 days in 1979, but levelled off quite rapidly and soon fell behind growth observed in 1980 and 1981. This event was associated with cooler water temperatures in 1979.

Water temperatures, as well as stocking rates or densities, appeared to strongly influence walleye growth. Mean weekly water

Table 7 . Covariance analysis of Lake Winnipegosis rearing pond walleye growth data. Length and age data transformed to natural logs.

Comparison	Slope F value and d.f.	Elevation F value and d.f.
Coleman Pond length growth curves from 1980 and 1981	1.6278 (1, 17)	1.6723 (1, 18)
Kelly Pond length growth curves from 1980 and 1981	3.3317 (1, 11)	0.9713 (1, 12)
Coleman Pond length growth curves, 1978 - 1981	4.8960 (3, 34)*	2.7469 (3, 37)
Freshwater Pond length growth curves, 1978 and 1981	1.2438 (1, 16)	1.1155 (1, 17)
Kelly Pond length growth curves 1978 - 1981	1.0267 (3, 23)	4.0933 (3, 26)*
Coleman Pond length growth curves from 15 to 71 days of age 1978 - 1981	10.677 (3, 10)*	2.2866 (3, 13)
Freshwater Pond length growth curves from 13 to 61 days of age 1978, 1979, 1981.	1.5389 (2, 6)	2.3030 (2, 8)
Kelly Pond length growth curves from 13 to 74 days of age 1978 - 1980	0.6834 (3, 8)	19.5290 (3, 11)*

* significant difference P = 0.05

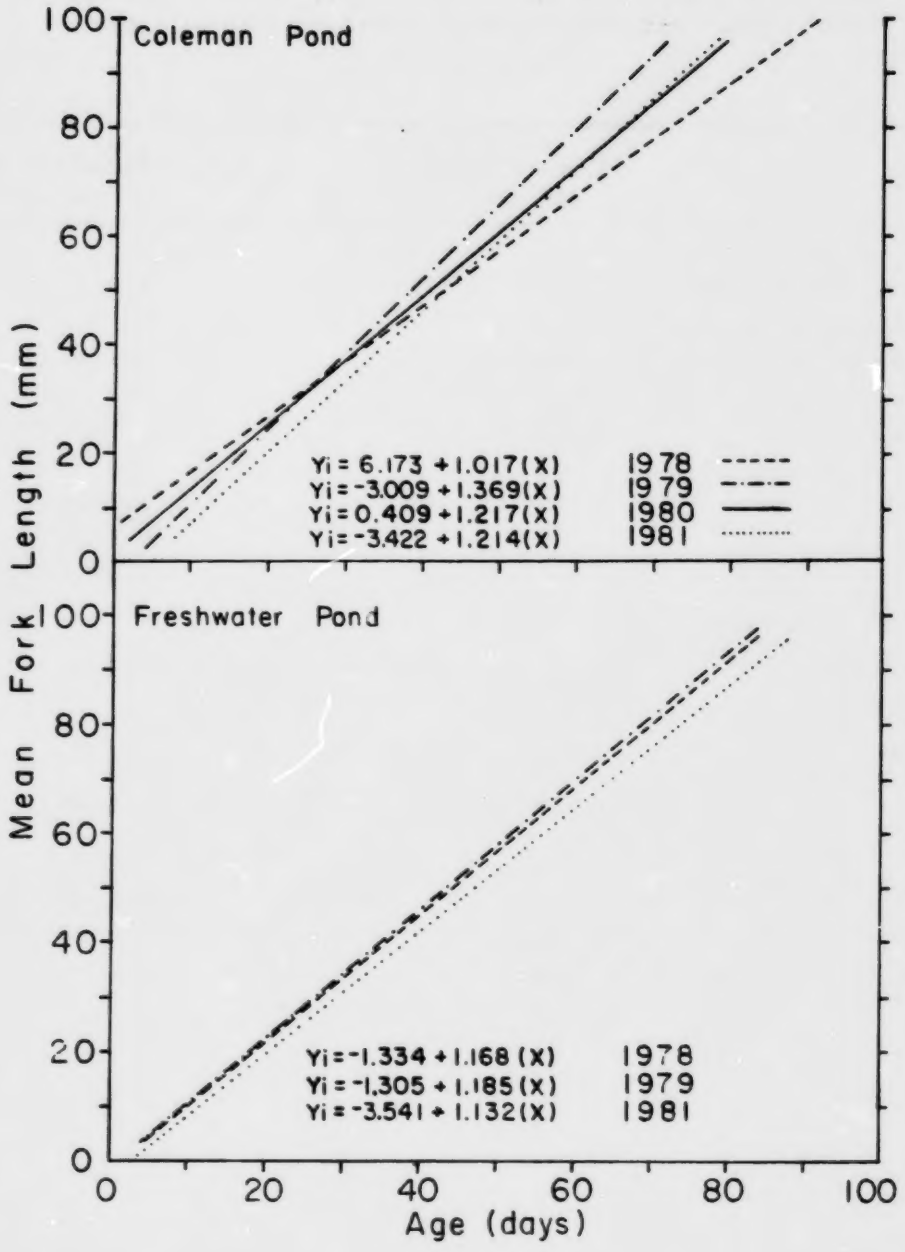


Fig. 13. Linear regression of 14 to 70 day old walleyes from Coleman and Freshwater ponds, 1978 to 1981.

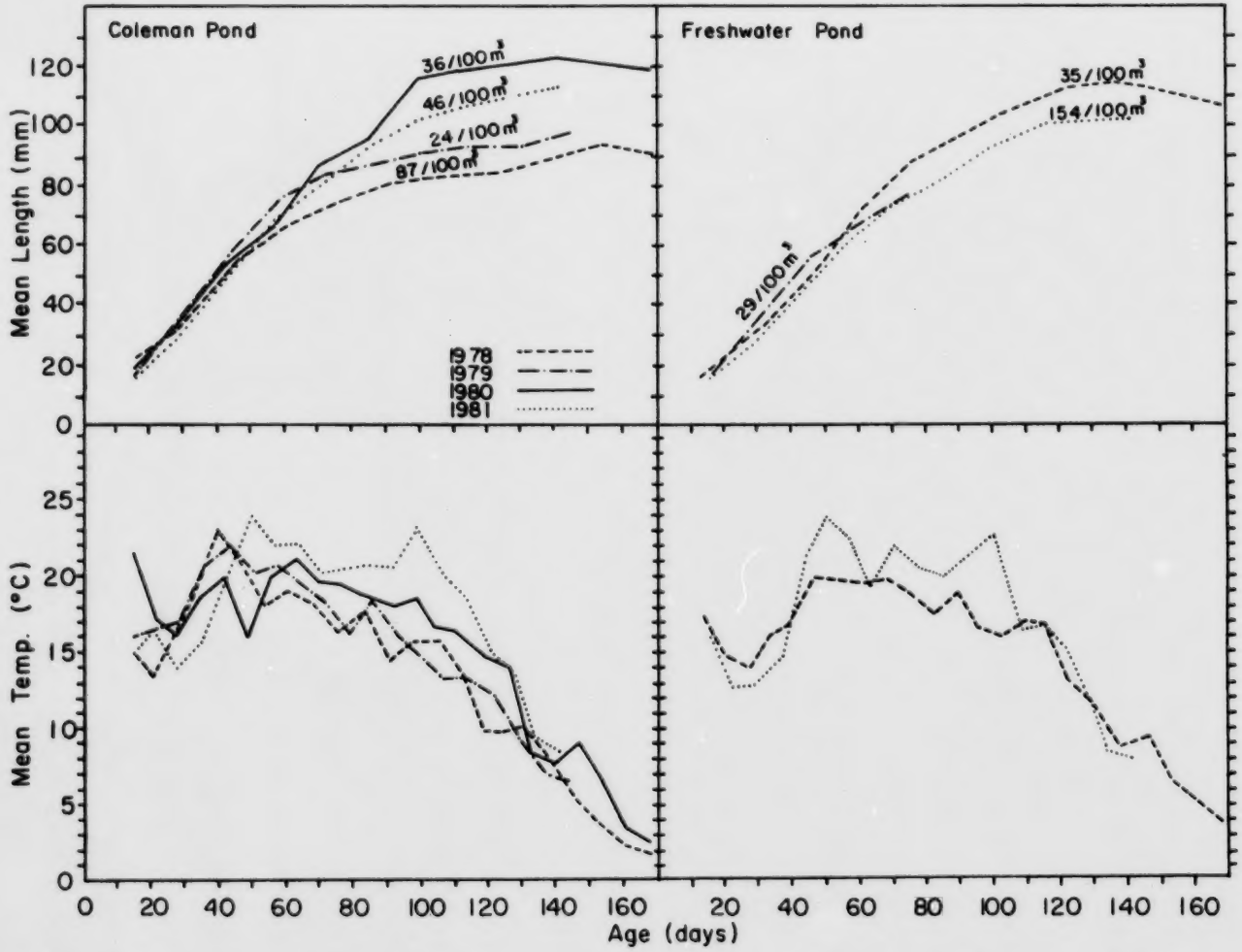


Fig. 14. Growth curves (with associated stocking density) and corresponding mean weekly water temperatures from Coleman and Freshwater ponds, 1978 to 1981.

temperatures of the rearing ponds were compared to the corresponding mean length of the walleye. Average weekly water temperatures were based on the water temperature on the day the walleye sample was taken plus the temperatures recorded on the six previous days. The growth rate of 20 - 60 day old walleye in Coleman Pond was greater in 1979 than in 1980 or 1981. The stocking density was lower in 1979 (24 100 m^{-3} compared to 36 - 87 100 m^{-3} in 1978, 1980 and 1981) and water temperatures were warmer for a period of 20 to 45 days (Fig. 14). The 1979 growth curve began flattening at about 70 days when water temperatures exhibited a gradual decline from 21 C (60 days) to 18 C (70 days). During similar time periods in 1980 and 1981, walleye growth surpassed the 1979 growth even though stocking densities were higher than in 1979. After 45 days, water temperatures in Coleman Pond in 1980 and 1981 generally exceeded the 1979 temperature and remained higher throughout the remainder of the season.

There were only two years of completed growth data for Freshwater Pond walleye so growth comparisons are limited. Lower stocking densities still reflected better growth (Fig. 14). Although best growth was achieved in 1978 when the stocking density was lowest, good growth was experienced in 1981 considering the stocking density was 4X that of 1978. When compared with growth curves of Coleman Pond walleye from 1978 and 1979, the growth of Freshwater Pond walleye had been greater after 85 to 90 days of age. Water temperatures in Freshwater Pond in 1981 were warmer from about 50 to 110 days following hatching (Fig. 14).

A multiple regression analysis involving water temperature, stocking density and walleye growth from Coleman Pond was calculated. The ratio between the deviation mean square and the total mean square of Y estimated that the fraction of variance of Y not attributable to the multiple regression was 0.234 while 0.766 is explained by the independent (x) variables. However, testing the effect of each independent variable after the effect of the other independent variable was removed showed no significant differences at $P \leq 0.05$ (Appendix 5). Data between 40 to 120 days from hatching had been used for this analysis. This was the time period when walleye growth curves began to diverge away from each other. By 120 days of age walleye growth had usually attenuated.

Population and Survival Estimates

Estimates of walleye populations in the rearing ponds were calculated using the three methods described by Green (1980). Two of the estimates involved the Schnabel (Method 1) and the Schumacher-Eschmeyer (Method 2) methods described by Ricker (1975). These methods were based upon multiple mark and recaptures of walleye which had been marked by a left pectoral fin clip. The multiple mark-recaptures were begun about 4 to 6 weeks prior to releasing the fingerling walleye from the rearing pond. The third method (Method 3) developed by Campbell and Rowse (1980) involved counting fin clipped and unmarked walleye fingerlings leaving the rearing ponds.

Population estimates calculated by using Method 3 for 1980 - 1981 data usually had narrower confidence limits about the means (Table 8). Similar observations were made in 1978 and 1979 (Green 1980). Unfortunately problems encountered during walleye releases from Coleman Pond in 1981 prevented a population estimate employing Method 3. Using Method 2, extremely wide confidence limits were approximately 3X the mean estimate (Table 8).

The estimates of walleye survival in Coleman and Freshwater ponds varied depending upon which population estimate was used. Survival ranged from 15 percent in 1980 to 65 percent in 1981 (Table 9). Although the 65 percent survival rate for Coleman Pond in 1981 may appear erroneously high, walleye survival was known to be better in 1981 than in 1978 and 1980 when survival estimates ranged between 15 and 27 percent. The high survival in Coleman Pond in 1981 is corroborated by the observation that 32 percent of the stocked fry were known to have escaped during the period releases were being monitored.

Releases and Production

When water temperatures stabilized at $\leq$ 14 C (mid to late September), walleye fingerlings were released from the rearing ponds to Lake Winnipegosis. The releases were made at the lower temperatures to reduce stress upon the walleye fingerlings when they were marked

Table 8. Population estimates from Coleman and Freshwater walleye rearing ponds, 1980 and 1981.

Location		1980			1981		
		Method 1	Method 2	Method 3	Method 1	Method 2	Method 3
Coleman	min	35,899	31,099	48,696	75,104	85,470	-
	estimate	39,709	37,177	50,988	116,223	143,639	
	max.	44,149	46,209	53,280	204,799	416,667	
Freshwater[1]	min.				126,422	112,360	263,327
	estimate	-	-	-	173,080	188,679	280,878
	max.				252,051	588,235	298,384

[1] no estimate calculated since Freshwater Pond was not used in 1980.

Table 9 . Survival estimates from Coleman and Freshwater walleye rearing ponds, 1978 to 1981.

Year	Coleman Pond			Freshwater Pond		
	Method 1	Method 2	Method 3	Method 1	Method 2	Method 3
1978	27	27	25	25	25	15
1979	52	48	49	N.D.	N.D.	N.D.
1980	16	15	21	N.D.	N.D.	N.D.
1981	53	65	-	26	29	43

N.D. = no data

by spraying with fluorescent dye. At higher temperatures spray marking and the coincident handling left the fish vulnerable to fungal attacks which resulted in considerable mortality.

The percentage of stocked walleye released was generally between 5 and 12 percent (Table 10). The highest release was 32 percent. According to population estimates, between 10 to 80 percent of the surviving walleye had left the rearing ponds (Table 10). Average releases, particularly from Coleman and Freshwater, appear to be in the range of 20 to 50 percent.

Releases from Coleman and Freshwater ponds into Lake Winnipegosis was by a natural movement of walleye through a culvert which was either 61 or 91 cm in diameter. These outward movements were noted to be greatly influenced by seiche activity on Lake Winnipegosis. The highest releases from these rearing ponds generally occurred during high south winds which lowered the lake level in Sagemace Bay and caused an outflow from the rearing ponds. Strong southerly winds which lasted for nearly a week in September 1981, resulted in an exceptionally good release from Coleman Pond. Approximately 55,000 of the 71,000 walleyes released from Coleman Pond in 1981, moved out during this week of heavy outflow.

The best walleye releases from Kelly Pond were between 13,000 in 1981 and 20,000 in 1979. These figures represented 3 to 10 percent of the numbers stocked (Table 10). Since Kelly

Pond was stocked with fry whose numbers were estimated "by eye", stocking rates probably fluctuated considerably. An extremely poor release was made from Kelly Pond in 1980. Observations throughout the summer had indicated the survival of stocked walleye in Kelly Pond was poor. The fish appeared to be discoloured and under some kind of stress, possibly caused by low water and an extended period of hot weather which occurred in 1980.

Estimates of production from the walleye rearing ponds varied from 1.0 to 9.0 kg ha^{-1}. The most typical production levels appeared to be 3 to 5 kg ha^{-1} (Table 10). Production estimates based on weight were not only affected by the number of walleye released, but also the mean weight of the walleye leaving the ponds. For example, in Coleman Pond, the numbers released in 1978 and 1981 were almost identical, but the production in 1981 was double that of 1978. The mean weight of walleye in 1981 was twice that of the fish in 1978 (Table 10). A comparison of mean weights at release versus stocking densities indicated that walleye stocked at a higher density usually had a lower mean weight.

Mark Recaptures

Routine monitoring of commercial walleye catches did not begin until 1980 since walleye are not recruited into the Lake Winnipegosis fishery until age 3+. Walleye released from the rearing ponds were not sprayed in large numbers until 1977.

There were 6 recoveries in 1980 and 15 in 1981 (Table 11). An additional four possible recoveries in 1980 are not considered here since the dye markings were doubtful.

The six recoveries in 1980 represented a marked/unmarked ratio of 1:5000; the ratio in 1981 was ten times greater or 1:500. Four times as many commercially caught walleye were examined in 1980 as in 1981. These results reflect the difficulties in detecting the marked fish with only a cursory examination under the ultraviolet light. Of the six recoveries in 1980, five were from the 1979 cohorts and one was from the 1978 cohort. Of the 15, 1981 recoveries, eight were marked in 1977, four in 1978 and three in 1979. These results indicate that the rearing pond walleye contributed less than one percent to those cohorts which were being recruited into the commercial fishery (Table 11).

Mark recaptures obtained by otter trawling suggested that the rearing ponds were contributing more to the Lake Winnipegosis fishery than indicated by the commercial catch monitoring. Marked recoveries of age 3+ or older walleye in 1980 and 1981 represented one to three percent of the samples of the 1977 and 1978 cohorts obtained by trawling (Table 11). Reared walleye appeared to make the greatest contribution to Lake Winnipegosis stocks as yearling fish. These contributions varied from 6 percent to at least as high as 14 percent.

Table 10. Numbers and percentage of walleyes released and production (wt.) of walleyes from walleye rearing ponds, 1978 to 1980.

Year		No. released[3]	No. released/no. stocked (%)	No. released/pop. estimate Method 1 (%)	Method 2 (%)	Method 3 (%)	Mean wt.[1] (gm)	Production[2] (kg/ha)
1978	Coleman	70,000	11	40	40	43	5.96	4
	Freshwater	29,000	12	48	48	80	14.4	4
	Kelly	19,000	10	21	22	19	10.3	3
1979	Coleman	13,000	5	10	11	11	7.5	1
	Kelly	20,000	10	N.D.	N.D.	N.D.	15.0	5
1980	Coleman	28,000	12	71	75	55	17.2	5
	Kelly	100	0.3	N.D.	N.D.	N.D.	10.4	-
1981	Coleman	71,000	32	61	49	-	13.6	9
	Freshwater	30,000	5	17	16	11	10.3	3
	Kelly	13,000	3	N.D.	N.D.	N.D.	6.4	1

1. Mean weight of walleyes when releases began.
2. Production calculated using actual numbers released.
3. Figures have been rounded off.

N.D. = no data

Table 11. Spray marked walleye recoveries obtained from commercial samples, ottertrawls and beach seines, 1977 to 1981.

Year	Commercial samples							Ottertrawls							Beach seines[2]		
	Total recaps	no. sampled (all age class)	no. recaps/year class and (%) contribution 1977	1978	1979	1980		Total recaps	no. sampled (all age class)	no. recaps/year class and (%) contribution 1977	1978	1979	1980		Total recaps	no. recaps/ year class 1978	1979
1979	3	489[1]	2(2.3)	2(<1)				2	65		2(5.9)				10	10	
1980	6	30,852	5(< 1)	1(<1)				5	260	1(3.0)	1(1.1)	3(5.8)			1		1
1981	15	7,873	8(< 1)	4(<1)	3(2.9)			3	187	1(3.3)	1(1.1)		1(14.3)		0		

1. All walleyes were commercial culls (92 had been headless dressed).
2. Generally only y-o-y walleyes were caught in the beach seines.

The greatest number of recoveries from beach seining was 10 yearling walleye caught in 1979. The only other recapture was one yearling walleye in 1980. Most of the walleye caught in the beach seining were young-of-the-year fish.

Otter trawling and beach seining were primarily done in the Sagemace Bay area of Lake Winnipegosis (Fig. 3). Commercial fishing was generally concentrated in the area south of Birch Island (Fig. 1). Except for 1980, commercial fishermen did not normally fish in the southern half of Sagemace Bay. Some fishing was also in the area east of Sagemace Bay.

DISCUSSION

Pond Stocking

During the stocking of Coleman and Freshwater ponds, extensive mortality of walleye eggs or fry were experienced in most years. This mortality seemed to be more related to environmental conditions than to improper handling techniques. Some revisions had been made to the stocking procedures employed in 1978 and these changes proved effective in 1980 and 1981. Mortalities that did occur during the latter two years appeared to be caused by either poor spawn or by poor water quality within the rearing ponds at the time of stocking.

Egg and fry mortality in 1980 was considered to have been caused primarily by poor spawn which resulted from abnormal water temperatures fluctuations that occurred while the eggs were being incubated at the hatchery. The total mortality of fry during the first attempt to stock Freshwater Pond in 1981 may have resulted from excessive amounts of marsh gas produced in the immediate vicinity of the egg cages which were set in the rearing pond. In 1981, water levels on Lake Winnipegosis were 0.3 to 0.6 m lower than in previous years and there was little or no movement of water through the control culvert into Freshwater Pond. In previous years when water levels were higher, this water movement into the rearing pond prevented stagnation and the buildup of toxic gases in and around the egg cages. A negligible mortality was observed on the second stocking attempt in 1981, when the egg cages were set in Lake Winnipegosis just opposite Freshwater Pond.

Food

The routine examination of walleye samples from Lake Winnipegosis rearing ponds revealed micro-crustaceans to be the most important food items in the diet of walleye fry at approximately 14 days of age and 13 to 20 mm in length. Cladocerans (eg. *Ceriodaphnia, Bosmina*) were generally more common than copepods, except in Kelly Pond walleye where copepods were a prominent diet item. Other investigators have similarly found cladocerans and copepods to be important in the early diet of walleye in rearing ponds (eg. Smith and Moyle 1945, Cheshire and Steele 1963, and Dobie 1969). Even in deeper and larger natural waterbodies, young-of-the-year walleye exhibit an initial preference for cladocerans and copepods (Hohn 1966, Houde 1967 Bukley *et al.* 1976 among others). Early food preferences of walleye in the Lake Winnipegosis rearing ponds in 1978 and 1979 (Gillies and Green 1980) were very similar to those observed in 1980 and 1981.

Walker and Applegate (1976) found that the food selection of young-of-the-year walleye in a South Dakota prairie pothole changed from copepods to forage fish, then to aquatic insects and finally to amphipods and leeches. A similar progression in food selection was observed in the diet of walleye in the Lake Winnipegosis rearing ponds. As they increased in size, they began selecting larger prey species. As might be expected, however, the change from micro-crustaceans to specific larger prey was never consistent from year to year. Annual variations in the food selectivity

of young walleye probably reflected changes in the availability or abundance of the different prey organisms in the rearing ponds.

Certain food types seemed to be more available to walleye in some ponds in some years than in other ponds in other years. For example, chironomid larvae were frequently eaten by 30-day old walleye, but the degree to which they were eaten varied between ponds and between years. Kelly Pond walleye normally switched from copepods and cladocerans to *Chaoborus*. This organism was very abundant in Kelly Pond, but not in other rearing ponds. *Chaoborus* was never found in walleye from Coleman and Freshwater ponds. In Coleman Pond, forage fish were more common in the walleye diet during 1980 and 1981 than in the previous two years. Coleman Pond walleyes also consumed higher percentages of chironomids, Odonata nymphs and corixids in 1981 than in any other year.

Numerous studies have shown that forage fish constitute a major food for young walleye (eg. Eschmeyer 1950, Maloney and Johnson 1955, Ridenhour 1960 and Parsons 1971). Variations in the occurrence of forage fish in the diets observed in the present study suggested the walleye were selecting them as they became more available. Forage fish were uncommon in the Lake Winnipegosis rearing ponds because of anoxic conditions in winter. Consequently, the abundance and availability of forage fish in the rearing ponds fluctuated annually. In Kelly Pond, very few forage fish were eaten by young walleye in 1978 and 1979. The forage

fish must have been present and surviving in the pond since Kelly Pond is isolated and cannot be replenished by immigration from Lake Winnipegosis or other waters. In 1981, forage fish were more important than *Chaoborus* in the diet of Kelly Pond walleye. For some reason, the forage fish survived winter-kill conditions or encountered good conditions for reproduction and became very abundant later in the summer. Smith and Moyle (1945) observed that walleye in rearing ponds consumed forage fish in proportion to their abundance.

Other investigators have found that the size of prey organisms can also influence the young walleye's choice of food. Priegal (1970) observed a preference by young-of-the-year walleye in Lake Winnibago for a larger species of plankton, *Leptodora*. This organism was selected even though it was the least abundant species of zooplankton; it was also eaten by walleye which were large enough to ingest it. Davis (1975) observed that young walleyes exhibited selectivity in terms of both the species and size of forage fish consumed.

The distribution of sizes of a given prey fish species may or may not influence the food selection of young walleye. Wolfert (1966) noted that young-of-the-year walleye in Lake Erie fed on the smallest individuals of a species of forage fish regardless of species preferences. In contrast, Parsons (1971) found that the length of forage fish increased with the length of walleye and that walleye of a given length generally preyed upon forage fish with a restricted length range. Measurements of forage fish in the Lake Winnipegosis rearing ponds were not

recorded, but there appeared to be a tendency for the walleye to select the smaller individuals of a given prey fish species.

The appearance of forage fish in the diet of walleye examined in this study was similar to results of other studies. In the Lake Winnipegosis rearing ponds, walleye began feeding on fish as early as May and June when the walleye were 13 to 16 mm (TL) long. Forage fish were observed in walleye 15 to 19 mm(TL) long in Minnesota rearing ponds (Smith and Moyle 1945). After walleye had reached a size of 40 - 50 mm (approx. 40 days) in the Lake Winnipegosis rearing ponds, they began feeding extensively on forage fish. Ridenhour (1960) and Smith and Pycha (1960) found that 50 - 60 mm walleye depended heavily on forage fish. Forage fish were an important diet item for 76 - 100 mm walleye in Lake Winnebago (Priegal 1970).

Amphipods had been consumed by walleye in all of the Lake Winnipegosis rearing ponds. Amphipods, however, appeared to be the food organism that was least preferred by the walleye. Amphipods appeared abundant in all rearing ponds throughout the openwater season. The greatest incidence of amphipods in the walleye diet was generally in late August, September or October when the occurrence of other food types in walleye was lower. This is similar to the results of Walker and Applegate (1976) who found that amphipods and leeches were of minor importance to young walleye in July and August, but contributed 68 percent of the food volume in September.

Growth

The growth of walleye in the Lake Winnipegosis rearing ponds during 1980 and 1981 exhibited the same general pattern of the 1978 and 1979 growth reported by Gillies and Green (1980). The growth rate was rapid from hatching until mid-summer when it began to level off. A similar growth pattern has been observed in under-yearling walleye examined from other area (Maloney and Johnson 1955, Smith and Pycha 1960, Priegal 1970, etc).

The growth of walleye in rearing ponds, as noted by Smith and Moyle (1945), may vary according to the availability of forage fish and the pond's fertility as well as the method employed in managing the rearing pond. In Oneida Lake, Forney (1966) found that the growth of age - 0 walleye during late summer was usually rapid when forage fish were eaten and slower when invertebrate organisms were common in the diet. In this study, Coleman Pond walleye relied heavily on forage fish in 1981 and exhibited better average growth than in 1978 - 1980. Consumption of forage fish, however, may not necessarily mean that best growth will be achieved. Walleye from Kelly Pond fed on forage fish to a large extent in 1981, but their growth was still better in 1979, when *Chaoborus* was the dominant diet item. Smith and Pycha (1960) also noted that the extent to which forage fish were eaten did not necessarily determine rate or total amount of first summer's growth in walleye.

Observations from the present study suggest that stocking density (space) and water temperature may be a more important determinant of walleye growth than food type. Better growth, especially within the first 70 days, usually corresponded with lower stocking densities (Fig. 14). Dobie (1969) concluded that space was likely more of a limiting factor to walleye growth than either food supply or differences in diet. Dobie noted that in Minnesota rearing ponds walleye grew just as rapidly on plankton and insects as on fish. He further noted that the amount of food available may not limit growth in length over time, but does limit the number of fish which can be reared to a certain length within 60 days. Osborn, cited by Dobie (1969), found that by feeding more food, a larger population of fish could be supported in a pond, but the growth of individual fish could not be increased.

The importance of temperature to walleye growth has been examined in numerous other studies under both laboratory and field conditions. Huh *et al.* (1976) found the influence of temperature on walleye growth to be highly significant ($P < 0.01$) when examined under laboratory conditions with 8 and 16 h photoperiods. One way in which temperature affects walleye growth is initiating feeding in the larvae (Hokanson 1977). Spring and early temperatures are therefore very important in determining the first summer's growth of walleye. Forney (1966) found a positive correlation between May - June air temperatures and the first year growth of Oneida Lake walleye. Serns (1982) noted that the growth of age - 0

walleye in Escanaba Lake were correlated to the mean water temperatures during June and May - June combined. The rate of warming and the degree of temperature fluctuations during the spring appear to be critical factors in growth and survival of young-of-the-year walleye. Water temperatures affect walleye growth rates, while food and temperature determined the asymptotic length (Hokanson 1977).

In the present study, water temperatures which remained close to the physiological optimum temperature for walleye tended to produce better growth. An optimum growth temperature of 22C has been reported by Koenst and Smith (1976) and Huh *et al.* (1976). Hokanson (1977) reported the preferred temperature range of walleye to be between 20.6 and 23.2C. Longer periods of warmer temperatures during 1980 and 1981 appeared to be responsible for the better growth of Coleman Pond walleye in these years even though stocking densities were higher than in 1979. Raney and Lachner (1942) observed that the greatest growth increments in walleye occurred after water temperatures reached the highest mean daily temperature and that a slackening of growth rate in September coincided with a sudden lowering of water temperatures. In the Lake Winnipegosis rearing ponds, walleye growth slowed at about 19C and would level off if temperatures decreased further (Fig. 14). Although temperatures throughout the first summer may be important to walleye growth, it seems the temperatures experienced early in the season are most influential on growth. Smith and Pycha (1960) found positive

correlations between the growth of young-of-the-year walleye and the summation of air-degree days above 7.2 and 10.0C, which included virtually the entire growing season from May through September, but none of these correlations were significant below the 15 percent level.

The average growth of walleye stocked in the rearing ponds did not appear substantially better than the growth of native young-of-the-year walleye in Lake Winnipegosis. Naturally produced age - 0 walleye in Lake Winnipegosis during mid July averaged 81 mm and 70 mm in length in 1980 and 1981, respectively. The average length of similar aged walleye in the rearing ponds varied between 78 to 87 mm in 1980 and 62 to 69 mm in 1981. In 1979, the average length of 102 underyearling walleye from Lake Winnipegosis captured on August 23 was 123 mm; the greatest mean length of walleye in the rearing ponds in early September, 1979, was 116 mm (Gillies and Green 1980).

A small number of walleye in the rearing ponds had, by the end of summer, grown considerably better than the native stock. These larger individuals were most commonly observed from Coleman Pond. In most cases, other smaller walleye were found in the stomachs of these large walleye. Scott *et al.* (1951) observed that walleye planted as larvae into Silver Lake eventually segregated into two size groups. They attributed this divergence in growth to cannibalism. Cannibalism in the Lake Winnipegosis rearing ponds was not apparent until late summer - early autumn.

Walleye growth in the Lake Winnipegosis rearing ponds was very similar to the growth of age - 0 walleye in waters located within approximately the same latitudes, but slower than in more southerly waters. Walleye growth recorded in this study were similar to young-of-the-year walleye growth in Lac La Ronge Saskatchewan. Underyearling walleye from Lac La Ronge attained 104 mm FL by the end of September (Rawson 1957). The average length of walleye from the Lake Winnipegosis rearing ponds at the end of September varied from 109 to 122 mm. (Tables 3 and 4). Rearing pond walleye in this study achieved slightly better growth after 60 days than walleye reared in Minnesota ponds. Dobie (1969) observed an average walleye length of 58 mm (40.6 - 88.9mm TL) in 60 days from some Minnesota rearing ponds. The average length of Lake Winnipegosis rearing pond walleye was 62 mm (46 - 83 mm) after 60 days. Young-of-the-year walleye from more southerly waters usually attained a larger size by the end of summer than did the walleye in this study. Walleye from Lake Winnebago, Wisconsin, attained mean lengths of 127 to 185 mm (Priegal 1970). In four mainstem Missouri River reservoirs, the most southerly of which is in South Dakota, the length of age - 0 walleye varied from 123 to 158 mm (Nelson and Walberg 1970).

Rearing Pond Contributions to Lake Winnipegosis

In the present study, the timing of releases of the walleye fingerlings from the Lake Winnipegosis rearing ponds was dictated by the resiliency of the walleye to handling. A good deal of additional handling of the fingerlings was required in order to meet some of the objectives of the study. This

extra handling involved inspection of each walleye for fin clips to provide an additional check on population estimates and the holding of walleye both in the trapnet attached to the outlet culvert and in tubs for the purpose of enumerating and spray marking them. The spray marking in itself probably placed a significant amount of stress on the young walleyes. Because of this added handling, releases could not be started too early. If water temperatures were too warm, the young walleye were severely stressed and highly prone to fungal attack and eventual death. Water temperatures less than 15C proved to be best (Green 1980). Releases from the Lake Winnipegosis rearing ponds were therefore not begun until sometime between mid and late September.

The number of walleye fingerlings released from the Lake Winnipegosis rearing ponds was usually only 5 to 12 percent of the number initially stocked and about half of the pond population estimated at the time of release. The highest release was for Coleman Pond where 32 percent of the number stocked was released. This large release was probably associated with wind conditions and associated lake seiches in 1981. Winds from the south caused water to leave Sagemace Bay, thereby creating outflows from the rearing ponds. Good releases from the ponds were associated with outflows in other years. Campbell and Rowse (1980) observed that the largest daily catches in (1977) seemed to occur when outflow velocities were greatest. Good releases were also noted during

periods of calm or moderate inflows. During strong inflows, however, movement of walleye from the pond did not occur. This might be expected since young walleye are poor swimmers and water velocities through the culverts probably exceeded their swimming capabilities.

It was difficult to adequately assess whether there was any association between stocking rates and the survival of walleye in the ponds or the escapement from the ponds. This difficulty arose mainly because of our inability to control pond water levels and to assure that all surviving walleye escaped or were released. Certainly, it appeared evident that there was no relationship between stocking rates and the numbers of fry surviving in the ponds up to the time releases began. Observations on Coleman Pond in 1978 and 1981 also indicated no relation between stocking rates and escapement. In each of these years, approximately 70,000 escaped. These yields occurred despite a stocking rate in 1978 that was three times that in 1981.

The release of walleye from Kelly Pond in all years and from Freshwater Pond in 1981 was effected by manual means using trap nets. Even with this method, the maximum number of walleye taken from each pond could not be increased by increasing the stocking rate. Approximately 2.5 times as many walleye were stocked in Kelly Pond in 1981 as in 1978, but 5000 more fingerlings were trapped out of the pond in 1978. Only 30,000 of the estimated

170,000 to 280,000 fingerlings walleye surviving in Freshwater Pond in 1981 could be trap netted. Four trap nets were used in Freshwater Pond. Initial catches were not extremely large and declined considerably even before any appreciable drop in water temperature occurred. Catches in the first few days ranged between 3000 and 7500 per day, but had dropped to less than 1000 when pond temperatures were still around 9C. It was expected that with approximately 200,000 fingerlings surviving in the pond, larger catches should have been made. Because of the very rapid decline in water temperatures, there is some question as to the effectiveness of the trap nets in capturing all the fingerlings in the pond. The pond temperature dropped from 8C to 2.5 C in two days. Since young-of-the-year walleye seem to become very lethargic at temperatures below 4C (W. Howard, personal communication), their movements are greatly curtailed and they are less vulnerable. In Freshwater Pond, average trap net catches of less than 200 per day were observed when water temperatures were below 4C. If higher water temperatures had prevailed, it is presumed that trap net catches would have remained high.

A better assessment of the rearing ponds capability to produce walleye would be possible if adequate outflows from the ponds could have been maintained. In order to maintain water levels and therefore outflows from the ponds, pumping is required. Because of the large size of the ponds, pumping has proven to be slow and costly. To overcome this problem, methods of stimulating the movement of walleye fingerlings from rearing ponds have been considered. In one case, copper sulphate

has been added to some Lake Winnipegosis rearing ponds in hopes it would irritate the walleye and drive them out of the ponds. This method achieved little or no success (W. Howard, personal communication). Attracting walleye to the pond exits or to trap nets with artifically created currents may be another possibility. Laarman and Reynolds (1974) were able to increase trap catches of young walleye by forcing a slight current through the trap's lead. Campbell and Rowse (1980) suggested using a electric seine net, which was being developed for harvesting trout ponds, to drive walleye out of the rearing pond or into a concentrated area for trapping.

The potential fish biomass production from the Lake Winnipegosis rearing ponds was variable. Based on population estimates before the walleye fingerlings were released from the ponds, potential yields production ranged from 6 to 18 kg ha^{-1} between 1978 and 1981. Campbell and Rowse (1980) reported a production of 7.1 kg ha^{-1} from Coleman Pond in 1977. Based on observed releases, production was generally 3 to 5 kg ha^{-1} with a high of 9 kg ha^{-1}. This production was extremely low compared to average levels of 44 to 54 kg ha^{-1} reported by Smith and Moyle (1945) and Miller (1952) for walleye rearing ponds in Minnesota. These ponds, however, were artifically fertilized and smaller in area which would make them more manageable. Stocking densities were also considerably higher and averaged 98,000 fry ha^{-1}. Walleye production from other Manitoba rearing ponds was similar to that found in the present study. Li and Ayles

(1981) found a mean production of 13.8 kg ha^{-1} from hatchery ponds and 7.6 kg ha^{-1} from farm dugouts near Winnipeg. They employed stocking rates of 6000 to 8000 fry ha^{-1} which were slightly higher than stocking rates (2000 to 6000 ha^{-1}) used in Lake Winnipegosis rearing ponds.

Increased stocking rates do not appear to be the solution to increasing the production from the rearing ponds. Comparisons between stocking densities and the mean weights of walleye fingerlings at release indicated that heavier walleye were associated with lower stocking densities. When the stocking density of Coleman Pond had been reduced by half in 1981, the mean weight of the walleye at the end of summer(13.6g) was more than twice the size (5.9 g) observed in 1978. As a result, even though the same numbers of walleye were released in 1978 and 1981, production in 1981 (9 kg ha^{-1}) was more than twice that (4 kg ha^{-1}) in 1978.

The recovery of spray marked walleye from the commercial fishermen's catches indicated that the production from the rearing ponds were making some contribution to the Lake Winnipegosis commercial fishery. This contribution, however, could not be adequately assessed since all walleye fingerlings released from the rearing ponds were not spray marked. For example, in 1978 approximately 56 percent of the walleye released from the ponds were marked. The numbers of walleye fingerlings spray marked between 1978 and 1981, ranged from 27,000 and 137,000 per year.

In addition to these marked fish, some numbers of unmarked walleyes undoubtedly escaped from the ponds after weather conditions became too inclement to maintain trapnets at the pond outlets.

Results of the study to date (Table 11) suggest that at best walleye fingerlings released from the rearing ponds are having a minimal impact on the Lake Winnipegosis commercial fishery. However, a variety of factors may have contributed to the small number of marked fish observed in the commercial catch monitoring. These factors relate to marking techniques and the retention of dye marks, detection of marks and the fate of marked fish.

Improper marking techniques may have resulted in a number of fish being poorly marked and subsequently loosing their marks. T. Smith (personal communication) indicated that the amount of air pressure used and the distance the spray nozzle is held from the fish are important in achieving good results. The fluorescent grit was properly embedded in the fish if a pressure of approximately 110 psi was used and the nozzle was held within 6 to 8 inches of the fish. In 1978, all fish may not have been properly marked since the nozzle was held one to two feet from the fish during spraying and air pressures less than 90 psi were used at times.

Observations have been made which indicated that walleye spray marked as fingerlings may retain dye markings for at least three to four years. Walleye, however, may lose

the dye marks overtime. In this study, it was usually the older marked walleye which showed the least amount of dye. When the fish were recaptured within a year after being sprayed, they exhibited relatively large, and easily detectible, amounts of fluorescent dye. When marked walleye of the same year class were recaptured after being extent three or four years, generally only a few flecks of dye remained on the fish. It would appear that the embedded fluorescent grit is either overgrown with new tissue or may be sloughed off with dead tissue. Retention and visibility of the dye probably depends on the amount and extent to which the grit is embedded, as well as its location on the fish.

A portion of the walleye that were examined from the commercial catches consisted of headless, dressed fish. In examining whole fish, dye markings were sometimes noted only on the head of some individuals. The initial processing of fish therefore could have obliterated a number of marked fish.

Definite problems were noticed with detecting some dye marks. During the inspection of samples from the commercial catches in the processing plant, each fish was examined for a period of about 10 sec or less. The time devoted to this inspection could not be appreciably prolonged as it would have excessively delayed the weighing and cool storage of the fish. Because of this limitation, some of the marked fish, particularly

those with only a few flecks of dye, could have been overlooked. T. Smith (personal communication) observed that in some cases known marked walleye from Black Beaver Lake, Manitoba, had to be viewed from one to two minutes under ultraviolet light in order to detect dye markings. It was also noted that observers with colour vision problems could not detect dye marks as readily.

The representation of marked walleye in the commercial catches may also have been determined by the extent to which they moved out of the Sagemace Bay area, the distribution of commercial fishing effort and by the natural mortality the marked fish experienced before being recruited into the commercial fishery. Rearing pond walleye did move out of Sagemace Bay. This was indicated by marked fish recoveries from the area north of Duck Bay and at least one recovery eat of Red Deer Point. Most of the commercial fishing in southern Lake Winnipegosis is conducted in an area 30 to 50 km north of Sagemace Bay, but south of Birch Island. Except for 1980, very little commercial fishing was ever done in Sagemace Bay during the period 1978 - 1981. The effect of annual mortality on mark recoveries in the commercial fishery would be to reduce the number of marks extent. Kempinger and Carline (1977) report the annual survival rates of age - 0 to age - 3 walleye under natural conditions to be between 32 and 61 percent. Laarman (1981) observed an average 26 percent survival of walleye fingerlings after one year; the walleye were stocked as 11 - 17 cm fingerlings.

First-year survival of walleye in Oneida Lake varied between 25 and 35 percent (Forney and Houde 1964). Schneider (1969) and Kempinger and Churchill (1972) estimated the survival of walleye from age - 0 to age - 3 to be between 10 and 15 percent. Regression analysis of Lake Winnipegosis catch curves for individual walleye year classes indicated annual survival rates of 25 to 50 percent after age - 4 (H. Valiant, personal communication). The survival of younger age classes of walleye in Lake Winnipegosis may not be much better than this since walleye younger than age - 3 are subjected to some fishing mortality. Interviews with commercial fishermen indicated that appreciable numbers of small walleye (age - 1 and 2) were frequently entangled by their teeth in gillnets during windy weather. The severity of the blow generally determined how many undersized walleye were caught. Given a relatively optimistic annual survival rate of 50 percent, then the number of marked walleye extant at age - 4, the age of maximum recruitment, would be only six percent of the initial number. Mortality factors, coupled with fish movements and the distribution of fishing effort, would therefore substantially reduce the number of marked fish recaptured by the commercial fishery.

Based on the commercial fishery data compiled so far, the contribution the rearing ponds are making to the Lake Winnipegosis fishery appear to be small. The reasons for this apparently small contribution have just been previously discussed. The actual size of the rearing pond contribution, however, many be larger than

indicated. A larger contribution by reared walleye is suggested in the results obtained from supplementary sampling. A greater proportion of marked walleye was observed in samples taken by otter trawling. This may be due to a number of factors. The trawl samples could be thoroughly examined for traces of dye markings. The trawl samples included yearling and two-year-old fish which would not have had the same opportunity to lose their marks or suffered as much mortality as older fish. There was some suggestion that the walleye released from the rearing ponds tended to remain around the ponds. Most otter trawling was done in Sagemace Bay in the area of Coleman and Freshwater ponds. Ten marked walleye of the 1978 cohort were captured by beach seining opposite Coleman and Freshwater ponds in 1979. These fish constituted 15 percent of the yearling walleye caught by beach seining or 10 per cent of all yearlings caught by both seining and trawling in 1979.

Some indication as to the potential success of the Lake Winnipegosis rearing ponds in supplementing native walleye populations in the lake may be suggested by the work of Laarman (1978). He reviewed available information on walleye stocking in 125 waterbodies over the last 100 years. He concluded that stocking of walleye fingerlings was successful in about 32 percent of cases where natural reproduction was limited or absent. To our knowledge, habitat changes have not progressed to the point where spawning or other environmental conditions for Lake Winnipegosis walleye

populations have been severely degraded. Rather, limited recruitment to the commercial fishery appears to be more a function of diminished parental stocks. The operation of the rearing ponds around Lake Winnipegosis are intended to supplement the natural adult walleye stocks. Laarman (1978) indicates that only about 5 percent of supplemented walleye plants according to past experience have proven successful. Rearing ponds contributions of less than 10 percent to the Lake Winnipegosis walleye stocks therefore may not be unrealistic. Additional data and a more rigorous analysis of rearing pond releases and mark recaptures, however, are required to fully assess the value of the Lake Winnipegosis walleye rearing project.

Laarman's (1978) review indicated that results achieved in stocking walleye into waters already inhabited by walleye are generally inconclusive. Laarman noted that although the survival rate of larger fingerlings appeared to be better than that of smaller fingerlings, success or failure of stocking was dependant more on the environmental and biological conditions of the waterbody than on the number or size of walleye planted. He concluded that supplemental stocking for best results should only be used to augment poor natural year classes. Use of the Lake Winnipegosis rearing ponds when poor environmental conditions conditions occur may lessen the impact of weak year classes on the commercial fishery. However, when environmental conditions

in Lake Winnipegosis are unconducive to good reproduction and survival, the adjacent rearing ponds are generally at low levels which complicates the release or retrieval of the reared walleyes. This problem may be overcome by technical means. The use of such means, however, is as Laarman (1978) noted, dependant on the cost of such measures and whether the benefits derived equal such cost.

SUMMARY

Assessment of walleye rearing ponds in the Sagemace Bay - Duck Bay areas of Lake Winnipegosis was continued in 1980 and 1981. The assessment involved the food habits, growth, survival and production of walleyes from the rearing ponds. An estimate of the rearing pond walleyes contribution to the native Lake Winnipegosis walleye stocks was also determined.

Micro-crustaceans were the main food types chosen by rearing pond walleyes within 15 to 20 days after hatching. Cladocerans were more important in Coleman and Freshwater ponds while copepods were of more importance in Kelly Pond. At about 30 days of age when the walleyes had attained lengths of 26 to 35 mm mean length, their diet began to diversify. By 40 to 45 days of age walleyes were generally feeding on larger food. These food types were usually chironomids, dipteran pupae, forage fish and amphipods. Amphipods were usually selected from mid-July when walleyes were about 60 days of age and the occurrence of other food types had decreased.

The choice of a specific food type other than micro-crustaceans was never consistent from year to year by walleyes in the same rearing pond. The most consistent conversion from a diet of micro-crustaceans to another food type took place in Kelly Pond. There, walleyes generally chose *Chaoborus* from late June to late August.

The incidence of other food types such a trichopterans, Odonata nymphs, corixids, plecopterans, etc., varied between rearing ponds and years. The frequency of appearance of these foods was usually minimal; they occurred in less than five percent of the stomachs examined for any one sample period.

The number of empty stomachs observed from all ponds increased during July and August. This was attributed to sampling methods rather than food availability. Walleye samples obtained within a few hours had few empty stomachs while the number of empty stomachs increased when overnight sets were required.

Walleye growth varied between ponds and between years. During 1980 and 1981 walleyes attained average lengths of 62 to 68 mm at 56 to 60 days of age. At about mid to late September (120 to 130 days of age), the average length of walleyes was usually 100 mm or more. The longest walleyes released from the rearing ponds in 1980 and 1981 were 164 and 157 mm, respectively. At any given time during 1980 and 1981, Coleman Pond walleyes were generally larger in length and weight than Freshwater or Kelly pond walleyes.

Walleye growth was rapid from hatching and tapered off in mid to late summer. The flattening of the growth curves appeared to coincide with the occurrence of bi-weekly length increments of less than 10 percent. Attenuation of walleye growth seemed to occur around 75 to 80 days from hatching. Walleye growth in Coleman Pond during 1980 didn't level off until about 105 days of age.

An analysis of covariance simultaneously conducted on the length growth curves from the four study years, 1978 - 1981, showed some significant differences at $P \leq 0.05$. Significant differences were found in the slopes of length growth curves for Coleman Pond walleyes and in the elevations of length growth curves for Kelly Pond walleyes.

Rearing ponds stocked at lower rates (no. fry ha^{-1}) or lower densities (no. fry 100 m^{-3}) frequently achieved better walleye growth than those stocked at higher rates or densities. Linear regressions of growth curves for 14 - 70 day old walleyes showed a better growth rate with a lower stocking density. However, better growth at the end of summer was not always associated with a lower stocking density. In 1979, even though Coleman Pond was stocked with the lowest density of walleyes, growth was less than found in 1980 and 1981. A major factor in this situation seemed to be the cooling down of water temperatures. Early growth had been greatest in 1979 up to 70 days of age, but when water temperatures started dropping to approximately 19°C growth also began levelling off. Water temperatures in 1980 and 1981 were warmer than those in 1979 at about 45 days from hatching and remained so throughout the season.

A multiple regression analysis involving water temperature, stocking density and walleye growth from Coleman Pond indicated that neither water temperature nor stocking density had a significant effect ($p \leq 0.05$) on walleye growth.

When water temperatures stabilized at $\leq 14^{o}C$ (mid to late September) walleye fingerlings were released from the ponds into Lake Winnipegosis. Lower water temperatures during the release period were required in order to reduce stress upon the walleye fingerlings when they were being marked with fluorescent dye. The percentage of stocked walleyes released from the ponds was generally between 5 and 12 percent. The highest release was 32 percent. Population estimates had indicated that survival of walleyes in the rearing ponds ranged from 15 percent in 1980 to 65 percent in 1981. Average releases, particularly from Coleman and Freshwater ponds, appeared to be in the range of 20 to 50 percent of the fish that had survived up to the time of release.

Estimates of production from the rearing ponds varied from 1.0 to 9.0 kg ha^{-1}. The most typical production levels seemed to be 3 to 5 kg ha^{-1}. Production appeared to be indirectly affected by stocking density. A comparison of mean weights at release versus stocking density indicated that walleyes stocked at a higher density usually had a lower mean weight. In Coleman Pond, the number released in 1978 and 1981 were almost identical but production in 1981 was double that of 1978. The mean weight of walleyes in 1981 had been double that of 1978.

Recoveries of spray marked walleyes in the commercial fishery indicate that the rearing pond walleyes contributed less than one percent to those cohorts which were being recruited. Mark

recoveries obtained by otter trawling suggested that the rearing ponds were contributing more than indicated by the commercial monitoring. Mark recoveries of age 3+ or older walleyes represented one to three percent of the 1977 and 1978 cohorts sampled from otter trawl catches. Reared walleyes seemed to make the greatest contribution as yearling fish as these contributions varied from 6 to 14 percent.

ACKNOWLEDGMENTS

The authors wish to acknowledge the participation of D. G. Gillies, who assisted in data collection throughout the 1980 - 1981 sampling seasons.

Appreciation is extended to the following employees of the Department of Natural Resources who helped in various ways. Messrs. H. Valiant, T. Smith and G. Edwards of the Western Region provided some technical and logistical assistance. Conservation Officers B. Brown and Rick Hildebrand permitted us to use the Regional facility at Good Harbour. H. Denby supplied helpful assistance during the time the rearing ponds were stocked. Dr. J. F. O'Connor edited this report. Mr. W. Lysack provided statistical advice.

We would also like to express our appreciation to the commercial fishermen of Good Harbour for allowing the time to view the walleyes from their catches.

Thanks are extended to B. Bean who typed this report.

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Appendix 1A. The number (and percentage) of walleye stomachs containing a particular food item - Coleman Pond, 1980.

Food Item		May	June		July		August		September			October	Total
Order	Family	28	10	28	8	22	5	20	1	16	30	28	
Trichoptera						1(2)							1(0.20)
Odonata							1(2)	1(2)		3(6)			5(0.91)
Coleoptera	Dytiscidae				3(6)	1(2)							4(0.73)
Hemiptera	Corixidae			5(10)	1(2)	2(4)			3(6)	1(2)			12(2.2)
	Notonectidae												
Diptera	Unidentified	1(2)		6(12)	10(20)	91(18)							26(4.7)
	Chaoborinae												
	Chironomidae		11(22)	3(6)	9(18)	13(26)	3(6)	2(4)	1(2)	1(2)	8(16)		51(9.3)
Plecoptera													
Ephemeroptera													
Cladocera		29(58)	34(68)		5(10)								68(12.4)
Copepoda		45(90)	23(46)	21(42)	19(38)	3(6)	1(2)						112(20.4)
Amphipoda						4(8)	5(10)	7(14)	16(32)	5(10)	7(14)		44(8.0)
Hirudinea													
Fish		2(4)	1(2)	20(40)	19(38)	26(52)	14(28)	11(22)	21(42)	7(14)	14(28)	16(32)	151(27.5)
Insect remains			1(2)		1(2)								2(0.40)
Plant matter					1(2)		1(2)		2(4)		3(6)	2(4)	9(1.6)
Digested matter		1(2)	5(10)	1(2)	4(8)	5(10)	4(8)	4(8)	3(6)	13(26)	14(28)	6(12)	60(10.9)
empty		1(2)	3(6)	3(6)	2(4)	4(8)	24(48)	29(58)	11(22)	24(48)	13(26)	28(56)	142(25.8)
no. of stomachs examined		50	50	50	50	50	50	50	50	50	50	50	550

Appendix 1B. The number (and percentage) of walleye stomachs containing a particular food item - Coleman Pond, 1981.

Food Item		June		July			August		September		October	Total
Order	Family	3	16	1	15	29	12	26	10	24	7	
Trichoptera									2(4)			2(0.4)
Odonata			1(2)			3(6)	17(34)	29(58)	14(28)	4(8)		68(13.6)
Coleoptera	Dytiscidae			1(2)		2(4)						3(0.6)
Hemiptera	Corixidae				10(20)	16(32)	12(24)	28(56)	13(26)			79(15.8)
	Notonectidae											
Diptera	Unidentified	1(2)	5(10)	12(24)	11(22)	19(38)	2(4)					50(10.0)
	Chaoborinae											
	Chironomidae		13(26)	23(46)	23(46)	33(66)	33(66)	36(72)	29(58)	2(4)	7(14)	199(39.8)
Plecoptera						1(2)						1(0.2)
Ephemeroptera												
Cladocera		39(78)	23(46)	43(86)	32(64)	36(72)	17(34)	24(48)	20(40)			234(46.8)
Copepoda		19(38)	33(66)	32(64)	23(46)	29(58)	2(4)	3(6)	1(2)			142(28.4)
Amphipoda			1(2)			5(10)	8(16)	13(26)	15(30)	6(12)	2(4)	50(10.0)
Hirudinea												
Fish			11(22)	3(6)	6(12)	1(2)	8(16)	7(14)	4(8)	2(4)	3(6)	45(9.0)
Insect remains						1(2)						1(0.2)
Plant matter								1(2)	2(4)			3(0.6)
Digested matter		1(2)	1(2)					1(2)		8(16)	8(16)	19(3.8)
empty		1(2)	4(8)	4(8)			3(16)	1(2)	2(4)	30(60)	30(60)	75(15.0)
no. of stomachs examined		50	50	50	50	50	50	50	50	50	50	500

Appendix 1C. The number (and percentage) of walleye stomachs containing a particular food item - Freshwater Pond, 1981.

Food Item		June		July			August		September	October	
Order	Family	5	18	3	16	29	13	28	12	8	Total
Trichoptera					3(6)		1(2)				4(0.90)
Odonata					1(2)	1(2)					4(0.90)
Coleoptera	Dytiscidae			2(4)		2(4)	3(6)	2(4)	1(2)		8(1.8)
Hemiptera	Corixidae										
	Notonectidae										
Diptera	Unidentified		11(22)	2(4)	1(2)	4(8)	5(10)	1(2)			24(5.3)
	Chaoborinae										
	Chironomidae	4(8)	1(2)		5(10)	3(6)	6(12)	1(2)	2(4)	6(12)	28(6.2)
Plecoptera											2(0.22)
Ephemeroptera			2(4)								56(12.4)
Cladocera		39(78)	12(24)	3(6)			1(2)	1(2)			18(4.0)
Copepoda		16(32)	2(4)								75(16.7)
Amphipoda					1(2)	7(14)	11(22)	7(14)	19(38)	30(60)	2(0.44)
Hirudinea							1(2)	1(2)			62(13.8)
Fish			12(24)		2(4)	5(10)	9(18)	27(54)	4(8)	3(6)	6(1.3)
Insect remains				2(4)			1(2)		1(2)	2(4)	1(0.22)
Plant matter									1(2)		49(10.9)
Digested matter		1(2)	12(24)	11(22)	7(14)		2(4)	1(2)	8(16)	7(14)	187(41.6)
empty		3(6)	6(12)	31(62)	33(66)	38(76)	28(56)	17(34)	19(38)	12(24)	
no. of stomachs examined		50	50	50	50	50	50	50	50	50	450

Appendix 1D. The number (and percentage) of walleye stomachs containing a particular food item - Kelly Pond, 1980.

Food Item		May	June		July		August		September		
Order	Family	29	10	24	8	23	6	20	2	29	Total
Trichoptera						1(2)	3(6)				4(1.2)
Odonata				3(6)	2(4)						5(1.5)
Coleoptera	Dytiscidae					2(4)	2(4)				4(1.2)
Hemiptera	Corixidae				2(4)						2(0.6)
	Notonectidae		3(6)	21(42)	10(20)	2(4)	1(2)				37(10.9)
Diptera	Unidentified	27(34)	43(86)	48(96)	48(96)	38(76)	25(50)	3(17)	2(29)		234(68.6)
	Chaoborinae		3(6)		1(2)	1(2)					5(1.5)
	Chironomidae										
Plecoptera											
Ephemeroptera											
Cladocera		6(12)	2(4)	1(2)							9(2.6)
Copepoda		39(78)									39(11.4)
Amphipoda				1(2)	3(6)	14(28)	8(16)	1(6)		1(6)	28(8.2)
Hirudinea											
Fish				8(16)	2(4)	3(6)	25(50)	10(56)	5(71)	7(44)	60(17.6)
Insect remains					1(2)						1(0.3)
Plant matter											
Digested matter		1(2)	3(6)	1(2)	1(2)	2(4)			1(14)	1(6)	10(2.9)
empty		6(12)	4(8)			5(10)	4(8)	6(33)		7(44)	32(9.4)
no. of stomachs examined		50	50	50	50	50	50	18	7	16	341

Appendix 1E. The number (and percentage) of walleye stomachs containing a particular food item - Kelly Pond, 1981.

Food Item		June	July		August	Total
Order	Family	6	3	30	28	
Trichoptera						
Odonata			1(2)			1(0.5)
Coleoptera	Dytiscidae			1(2)	2(4)	3(1.5)
Hemiptera	Corixidae					
	Notonectidae					
Diptera	Unidentified					
	Chaoborinae		7(14)	16(32)		23(11.5)
	Chironomidae	3(6)		1(2)		4(2.0)
Plecoptera						
Ephemeroptera						
Cladocera		7(14)	3(6)	10(20)		20(10.0)
Copepoda		50(100)	1(2)			51(26.0)
Amphipoda				10(20)	3(6)	13(6.5)
Hirudinea				6(12)		6(3.0)
Fish		3(6)	24(48)	19(38)	12(24)	58(29.0)
Insect remains			2(4)			2(1.0)
Plant matter					1(2)	1(0.5)
Digested matter			1(2)	7(14)	3(6)	11(5.5)
empty			15(30)	5(10)	30(60)	50(25.0)
no. of stomachs examined		50	50	50	50	200

Appendix 2A. The total number (and percentage) of each food item consumed by Coleman Pond walleyes during each sample period, 1980.

Food Item		May	June		July		August		September			October	Total
Order	Family	28	10	23	8	22	5	20	1	16	30	28	
Trichoptera						1(0.2)						1(-)	
Odonata							1(2.9)	1(2.8)		5(13.9)		7(0.13)	
Coleoptera	Dytiscidae				4(0.2)	1(0.2)						5(0.10)	
Hemiptera	Corixidae			47(5.2)	1 -	2(0.4)			3(3.1)	1(2.8)		54(1.0)	
	Notonectidae												
Diptera	Unidentified	1(0.3)		69(7.7)	98(5.8)	41(8.6)						209(4.0)	
	Chaoborinae												
	Chironomidae		23(26.4)	3(0.3)	60(3.5)	208(43.8)	4(11.4)	2(5.6)	1(1.0)	1(2.8)	18(28.1)	320(6.2)	
Plecoptera-Ephemeroptera													
Cladocera		77(23.8)	1295(39.1)		41(2.4)								1413(27.1)
Copepoda		243(75)	191(26.4)	759(84.2)	1466(86.4)	180(37.9)	1(2.9)						2840(54.5)
Amphipoda						5(1.1)	6(17.1)	18(50.0)	65(67.7)	8(22.2)	14(21.9)		116(2.2)
Hirudinea													
Fish		2(0.6)	1(1.2)	23(2.6)	20(1.2)	32(6.7)	18(51.4)	11(30.6)	24(24.5)	8(22.2)	15(23.4)	17(68.0)	171(3.4)
Insect remains			1(1.2)		1 -								2(-)
Plant matter					1 -		1(2.9)		2(2.1)		3(4.7)	2(8.0)	9(0.2)
Digested matter		1(0.3)	5(5.8)	1(0.1)	4(0.2)	5(1.1)	4(11.4)	4(11.1)	3(3.1)	13(36.1)	14(21.9)	6(24.0)	60(1.2)
Total no. of items		324	1516	902	1696	475	35	36	98	36	64	25	5207
No. of empty stomachs		1	3	3	2	4	24	29	11	24	13	28	142
No. of stomachs examined.		50	50	50	50	50	50	50	50	50	50	50	550

Appendix 2B. The total number (and percentage) of each food item consumed by Coleman Pond walleyes during each sample period, 1981.

Food Item		June		July			August		September		October	Total
Order	Family	3	16	1	15	29	12	26	10	24	7	
Trichoptera									2(0.1)			2(-)
Odonata			2(0.3)			11(0.3)	34(1.4)	133(7.4)	40(2.6)	5(11.6)		225(1.2)
Coleoptera	Dytiscidae			1(-)		4(-)						5(-)
Hemiptera	Corixidae				26(0.7)	65(1.5)	253(10.2)	169(9.4)	24(1.6)			537(2.9)
	Notonectidae											
Diptera	Unidentified	1(0.5)	6(0.9)	22(0.6)	47(1.3)	43(1.0)	5(0.2)					124(0.7)
	Chaoborinae											
	Chironomidae		20(3.0)	68(1.9)	197(5.4)	234(5.2)	513(20.7)	325(18.1)	507(33.2)	5(11.6)	143(88.8)	2012(10.9)
Plecoptera						1(-)						1(-)
Ephemeroptera												
Cladocera		126(63.6)	370(55.6)	1198(34.2)	1417(38.6)	1628(36.5)	1646(66.5)	1086(60.6)	890(58.2)			8361(45.2)
Copepoda		70(35.4)	255(38.3)	2209(63.1)	1982(53.9)	2464(55.2)	2(-)	37(2.1)	1(-)			7020(37.9)
Amphipoda			1(0.2)			15(0.3)	15(0.6)	32(1.8)	59(3.9)	23(53.5)	7(4.4)	152(0.8)
Hirudinea												
Fish			11(1.7)	3(-)	6(0.2)	1(-)	8(0.3)	8(0.5)	4(0.3)	2(4.5)	3(1.9)	46(0.3)
Insect remains						1(-)						1(-)
Plant matter								1(-)	2(0.1)			3(-)
Digested matter		1(0.5)	1(0.2)					1(-)		8(18.6)	8(5.0)	19(0.1)
Total no. of items		198	666	3501	3675	4467	2476	1792	1529	43	161	18508
No. of empty stomachs		1	4	4			3	1	2	30	30	75
No. of stomachs examined		50	50	50	50	50	50	50	50	50	50	500

Appendix 2C. The total number (and percentage) of each food item consumed by Freshwater Pond walleyes during each sample period, 1981.

Food Item		June		July			August		September	October	Total
Order	Family	5	18	3	16	29	13	28	12	8	
Trichoptera					3(7.3)		1(0.6)				4(0.4)
Odonata				2(2.8)	1(2.4)	1(1.3)					4(0.4)
Coleoptera	Dytiscidae					2(2.7)	15(9.0)	2(1.7)	1(0.8)		20(2.2)
Hemiptera	Corixidae										
	Notonectidae										
Diptera	Unidentified		16(20.3)	4(5.6)	1(2.4)	7(9.3)	28(16.8)	14(12.1)			70(7.6)
	Chaoborinae										
	Chironomidae	5(3.6)	1(1.3)		24(58.5)	34(45.3)	26(15.6)	2(1.7)	3(2.5)	7(6.2)	102(11.0)
Plecoptera											
Ephemeroptera			1(1.3)								1(0.1)
Cladocera		98(69.5)	22(27.9)	53(73.6)			30(18.0)	16(13.8)			219(23.7)
Copepoda		37(26.2)	3(3.8)								40(4.3)
Amphipoda					3(7.3)	26(34.7)	53(31.7)	24(20.7)	100(82.6)	94(83.2)	300(32.4)
Hirudinea							2(1.2)	1(0.9)			3(0.3)
Fish			24(30.4)		2(4.9)	5(6.7)	9(5.4)	56(48.3)	7(5.8)	3(2.7)	106(11.5)
Insect remains				2(2.8)			1(0.6)		1(0.8)	2(1.8)	6(0.7)
Plant matter									1(0.8)		1(0.1)
Digested matter		1(0.7)	12(15.2)	11(15.3)	7(17.1)		2(1.2)	1(0.9)	8(6.6)	7(6.2)	49(5.3)
Total no. of items		141	79	72	41	75	167	116	121	113	925
No. of empty stomachs		3	6	31	33	38	28	17	19	12	187
No. of stomachs examined		50	50	50	50	50	50	50	50	50	450

Appendix 2D. The total number (and percentage) of each food item consumed by Kelly Pond walleyes during each sample period, 1980.

Food Item		May	June		July		August		September		Total
Order	Family	29	10	24	8	23	6	20	2	29	
Trichoptera											
Odonata						1(0.1)	3(0.5)				4(0.1)
Coleoptera	Dytiscidae			3(0.4)	2(0.3)						5(0.1)
Hemiptera	Corixidae					2(1.9)	2(0.3)				4(0.1)
	Notonectidae				2(0.3)						2(-)
Diptera	Unidentified		4(3.2)	76(11.0)	14(2.2)	2(1.9)	1(0.2)				97(2.5)
	Chaoborinae	35(5.6)	115(90.6)	599(86.8)	611(95.8)	1049(97.1)	627(93.6)	43(79.6)	14(70)		3093(78.9)
	Chironomidae		3(2.4)		1(0.2)	1(0.1)					5(0.1)
Plecoptera											
Ephemeroptera											
Cladocera		24(3.8)	2(1.6)	2(0.3)							28(0.7)
Copepoda		569(90.5)									569(14.5)
Amphipoda				1(0.1)	4(0.6)	20(1.9)	8(1.2)	1(1.9)		3(27.3)	37(0.9)
Hirudinea											
Fish				8(1.2)	2(0.3)	3(0.3)	29(4.3)	10(18.5)	5(25)	7(63.6)	64(1.6)
Insect remains					1(0.2)						1(-)
Plant matter											
Digested matter		1(0.2)	3(2.4)	1(0.1)	1(0.2)	2(1.9)			1(5)	1(9.1)	10(0.3)
Total no. of items		629	127	690	638	1080	670	54	20	11	3919
No. of empty stomachs		6	4			5	4	6		7	32
No. of stomachs examined.		50	50	50	50	50	50	18	7	16	341

Appendix 2E. The total number (and percentage) of each food item consumed by Kelly Pond walleyes during each sample period, 1981.

Food Item		June	July		August	Total
Order	Family	6	3	30	28	
Trichoptera						2(0.1)
Odonata						4(0.3)
Coleoptera	Dytiscidae		2(1.7)			
Hemiptera	Corixidae			1(0.1)	3(11.5)	
	Notonectidae					
Diptera	Unidentified					
	Chaoborinae		20(17.0)	602(59.7)		622(44.7)
	Chironomidae	3(1.3)		1(0.1)		4(0.3)
Plecoptera						
Ephemeroptera						
Cladocera		8(3.3)	56(47.5)	353(35.0)		417(30.0)
Copepoda		226(94.2)	13(11.0)			239(17.2)
Amphipoda				18(1.8)	7(26.9)	25(1.8)
Hirudinea				6(0.6)		6(0.4)
Fish		3(1.3)	24(20.3)	20(2.0)	12(46.2)	59(4.2)
Insect remains			2(1.7)			2(0.1)
Plant matter					1(3.9)	1(-)
Digested matter			1(0.9)	7(0.7)	3(11.5)	11(0.8)
Total no. of items		240	118	1008	26	1392
No. of empty stomachs			15	5	30	50
no. of stomachs examined		50	50	50	50	200

Appendix 3A. Estimates of food content proportions found in walleye stomachs from Coleman Pond, 1981.

Food Item Order	Family	June 3	June 16	July 1	July 15	July 29	August 12	August	September 10	September 24	October 7	Total
Trichoptera									50(1.0)			50(0.1)
Odonata			95(2.1)			110(2.2)	204(4.3)	935(19.1)	444(9.3)	340(17.0)		2128(5.0)
Coleoptera	Dytiscidae			10(.22)		25(0.5)						35(-)
Hemiptera	Corixidae				458(9.2)	621(12.4)	520(11.1)	870(17.8)	501(10.4)			2970(6.7)
	Notonectidae											
Diptera	Unidentified	80(1.6)	285(6.2)	144(3.1)	255(5.1)	331(6.6)	42(0.9)					1137(2.7)
	Chaoborinae											
	Chironomidae		505(11)	649(14.1)	566(11.3)	1191(33.8)	2137(45.5)	1004(20.5)	1646(34.3)	70(3.5)	700(35)	8468(19.9
Plecoptera						40(0.8)						40(-)
Ephemeroptera												
Cladocera		3288(67.1)	1071(23.3)	2060(44.8)	2424(48.5)	1707(34.1)	1106(23.5)	1110(22.7)	1048(21.8)			13814(32.9
Copepoda		1432(29.2)	1659(36.1)	1527(33.2)	697(13.9)	744(14.9)	2 -	11(.2)	1 -			6073(14.3
Amphipoda			45(1.0)			122(2.4)	125(2.7)	435(8.9)	750(15.6)	590(29.5)	200(10)	2267(5.3)
Hirudinea												
Fish			880(19.1)	210(4.6)	600(12)	80(1.6)	564(12)	500(10.2)	275(5.7)	200(10.0)	300(15)	3609(8.5)
Insect remains						29(0.6)						29(-)
Plant matter								5(0.1)	85(1.8)			90(0.2)
Digested matter		100(2)	60(1.3)					30(0.6)		800(40.0)	800(40)	1790(4.2)
Total proportion value		4900	4600	4600	5000	5000	4700	4900	4800	2000	2000	42500
No. of stomachs examined		50	50	50	50	50	50	50	50	50	50	500

Appendix 3B. Estimates of food content proportions found in walleye stomachs from Freshwater Pond, 1981.

Food Item		June		July			August		September	October	Total
Order	Family	5	18	3	16	29	13	28	12	8	
Trichoptera					165(6.1)		4(0.2)				169(0.6)
Odonata					40(1.5)	5(0.4)					245(0.9)
Coleoptera	Dytiscidae			200(10.5)		37(3.1)	121(5.5)	11(0.3)	2 -		171(0.6)
Hemiptera	Corixidae										
	Notonectidae										
Diptera	Unidentified		850(19.3)	170(9.0)	100(3.7)	33(2.8)	168(7.6)	35(1.1)			1356(5.0)
	Chaoborinae										
	Chironomidae	215(4.6)	50(1.1)		395(14.6)	110(9.2)	113(5.1)	30(0.9)		255(6.7)	1172(4.3)
Plecoptera											
Ephemeroptera			100(2.3)								100(0.4)
Cladocera		3375(71.8)	970(22.1)	230(12.1)			5(0.2)	5(0.2)			4585(16.8)
Copepoda		1050(22.3)	100(2.3)								1150(4.2)
Amphipoda					100(3.7)	515(42.9)	655(29.8)	352(10.7)	1889(60.9)	2590(68.2)	6101(22.4)
Hirudinea							100(4.6)	100(3.0)			200(0.7)
Fish			1130(25.7)		200(7.4)	500(41.6)	894(40.6)	2667(80.8)	395(12.7)	235(6.2)	6021(22.1)
Insect remains				200(10.5)			30(1.4)		5(0.2)	65(1.7)	300(1.1)
Plant matter									5(0.2)		5(-)
Digested matter		60(1.3)	1200(27.3)	1100(57.9)	1700(63.0)		110(5.0)	100(3.0)	800(25.8)	655(17.2)	5725(21.0)
empty											
Total proportion value		4700	4400	1900	2700	1200	2200	3300	3100	3800	27300
No. of stomachs examined		50	50	50	50	50	50	50	50	50	450

Appendix 3C. Estimates of food content proportions found in walleye stomachs from Kelly Pond, 1981.

Food Item		June	July		August	Total
Order	Family	6	3	30	28	
Trichoptera						
Odonata						
Coleoptera	Dytiscidae		95(2.7)			95(0.6)
Hemiptera	Corixidae			5(0.1)	105(5.5)	110(0.7)
	Notonectidae					
Diptera	Unidentified					
	Chaoborinae		555(15.9)	1060(23.6)		1615(10.8)
	Chironomidae	120(2.4)		5(0.1)		125(0.8)
Plecoptera						
Ephemeroptera						
Cladocera		145(2.9)	203(5.8)	545(12.1)		893(6.0)
Copepoda		4515(90.3)	2(-)			4517(30.3)
Amphipoda				220(4.9)	215(11.3)	435(2.9)
Hirudinea				535(11.9)		535(3.6)
Fish		220(4.4)	2345(67)	1675(37.2)	1180(62.1)	5420(36.4)
Insect remains			200(5.7)			200(1.3)
Plant matter					100(5.3)	100(0.7)
Digested matter			100(2.9)	455(11.9)	300(15.8)	855(5.7)
Total proportion value		5000	3500	4500	1900	14,900
No. of stomachs examined		50	50	50	49	199

Appendix 4A. The number and percentage occurrence of an individual food item based on the sum of all occurrences found in each rearing pond, 1980.

Food item		Coleman		Kelly	
		no. of occurrences	%	no. of occurrences	%
Trichoptera		1	(0.15)		
Odonata		4	(0.59)	4	(0.85)
Coleoptera	Dytiscidae	4	(0.59)	5	(1.1)
Hemiptera	Corixidae	12	(1.8)	4	(0.85)
	Notonectidae				
Diptera	Unidentified	26	(3.8)	37	(7.9)
	Chaoborinae			234	(50.0)
	Chironomidae	51	(7.5)	2	(0.43)
Plecoptera					
Ephemeroptera					
Cladocera		63	(9.3)	9	(1.9)
Copepoda		112	(16.5)	39	(8.3)
Amphipoda		45	(6.6)	28	(6.0)
Hirudinea					
Fish		151	(22.2)	60	(12.8)
Insect remains		2	(0.29)	1	(0.21)
Plant matter		6	(0.88)		
Digested matter		60	(8.8)	11	(2.4)
Empty stomachs		142	(20.9)	32	(6.8)
Total no. of occurrences		679		468	
No. of stomachs		550		341	

Appendix 4B. The number and percentage occurrence of an individual food item based on the sum of all occurrences found in each rearing pond, 1981.

Food Item		Coleman		Freshwater		Kelly	
		no. of occurrences	%	no. of occurrences	%	no. of occurrences	%
Trichoptera		2	(0.21)				
Odonata		68	(7.0)	4	(0.76)		
Coleoptera	Dytiscidae	3	(0.31)	4	(0.76)	1	(0.42)
Hemiptera	Corixidae	78	(8.1)	8	(1.5)	3	(1.3)
	Notonectidae						
Diptera	Unidentified	50	(5.2)	24	(4.6)		
	Chaoborinae					23	(9.8)
	Chironomidae	199	(20.5)	28	(5.3)	4	(1.7)
Plecoptera		1	(0.10)				
Ephemeroptera				1	(0.19)		
Cladocera		234	(24.2)	56	(10.7)	20	(8.5)
Copepoda		141	(14.6)	18	(3.4)	50	(21.2)
Amphipoda		50	(5.2)	75	(14.3)	13	(5.5)
Hirudinea				2	(0.38)	6	(2.5)
Fish		45	(4.6)	62	(11.8)	58	(24.6)
Insect remains		1	(0.10)	6	(1.1)	2	(0.85)
Plant matter		3	(0.31)	1	(0.19)	1	(0.42)
Digested matter		19	(2.0)	49	(9.3)	10	(4.2)
Empty stomach		75	(7.7)	187	(35.6)	45	(19.1)
Total no. of occurrences		969		525		236	
No. of stomachs		500		450		200	

Appendix 5 . Multiple regression involving water temperature, stocking density and walleye growth for the time period from 40 to 120 days from hatching, Coleman Pond, 1978 - 1980.

Sample	X_1 (temp. regression slope)	X_2 (stocking density, #/100 m^3)	Y (growth length regression slope)
Coleman Pond 1978	$-8.59757 \cdot 10^{-3}$	87	$5.15694 \cdot 10^{3}$
Coleman Pond 1979	$-7.20194 \cdot 10^{-3}$	24	$5.94079 \cdot 10^{3}$
Coleman Pond 1980	$-3.87122 \cdot 10^{-3}$	36	$9.99796 \cdot 10^{3}$
Coleman Pond 1981	$-3.56197 \cdot 10^{-3}$	46	$8.77136 \cdot 10^{3}$

Multiple regression equation: $Y = 0.01256407 + (0.9016066)\ X_1 + (.0000028888)\ X_2$

ANOVA:

Source	d.f.	S.S.	M.S.
Total	3	$1.577 \cdot 10^{-5}$	$5.26 \cdot 10^{-6}$
regression	2	$1.454 \cdot 10^{-5}$	$7.27 \cdot 10^{-6}$
deviation	1	$1.23 \cdot 10^{-6}$	$1.23 \cdot 10^{-6}$

F = 5.91057 with 2 and 1 d.f.

Source	d.f.	S.S.	M.S.
X_1 and X_2	2	$1.454 \cdot 10^{-5}$	
X_1 alone	1	$1.452 \cdot 10^{-5}$	
X_2 after X_1 discounted	1	$.02 \cdot 10^{-6}$	$.02 \cdot 10^{-6}$

F = 0.0163 with 1 and 1 d.f.

X_1 and X_2	2	$1.454 \cdot 10^{-5}$	
X_2 alone	1	$3.329 \cdot 10^{-6}$	
X_1 after X_2 discounted	1	$1.1211 \cdot 10^{-5}$	$1.1211 \cdot 10^{-5}$

F = 9.1146 with 1 and 1 d.f.